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SMICKSBURG QUADRANGLE

GEOLOGY AND MINERAL RESOURCES

By

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DEPARTMENT OF INTERNAL AFFAIRS
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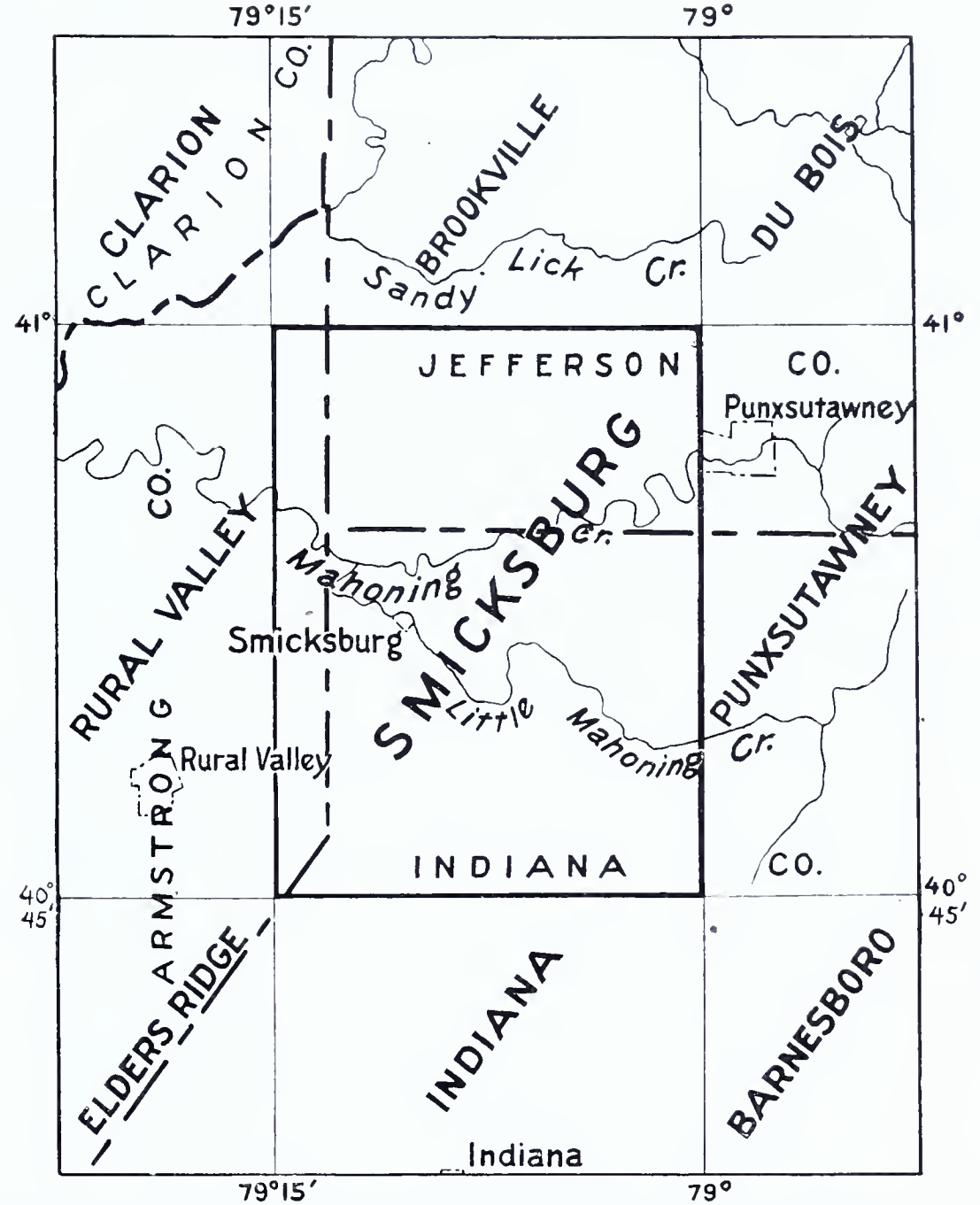

Figure 1. Sketch map showing the location of the Smicksburg quadrangle.

GEOLOGY AND MINERAL RESOURCES OF THE SMICKSBURG QUADRANGLE, PENNSYLVANIA

By Marchant N. Shaffner

INTRODUCTION

Location and Area

In accordance with the settled policy of the Pennsylvania Geological Survey and the U. S. Geological Survey, Pennsylvania is being mapped topographically in quadrangular areas, bounded by 15-minute meridians of longitude and parallels of latitude, each quadrangle being named after a prominent place in that area. The quadrangles are numbered from west to east and from north to south. The Smicksburg quadrangle, No. 55 as shown in figure 1, lies west of the center of Pennsylvania. It includes an area of 225.9 square miles bounded by parallels north 41° 00′ and 41° 15′ and meridians west 79° 00′ and 79° 15′. It is bounded on the north, east, south and west by the Brookville, Punxsutawney, Indiana and Rural Valley quadrangles respectively, and includes parts of southwestern Jefferson, northwestern Indiana and eastern Armstrong counties. Its length from north to south is about 17.3 miles, and its width from east to west at the south is about 13.1 miles, and at the north is about .05 of a mile shorter, owing to the convergence of the meridians.

Following are the areas of townships and parts of townships in the Smicksburg quadrangle:

	Square miles		Square miles		Square miles
Cowanshannock	10.06	Perry	28.88	South Mahoning	29.02
East Mahoning	30.41	Porter	17.94	Washington	7.39
McCalmont	.26	Rayne	3.61	Wayne	9.55
North Mahoning	25.97	Redbank	10.89	West Mahoning	29.6
Oliver	6.64	Ringgold	10.28	Young	5.36

This Report

The Smicksburg quadrangle lies within one of the important soft coal mining and natural gas producing areas in the State. These resources have been exploited for many years. The production of natural gas is declining, but the coal reserves equal and probably exceed that which has already been removed. Besides those natural resources, there are extensive deposits of clay, shale, sandstone, and limestone which are mostly undeveloped. Because of the economic value of these mineral resources, and of the fact that detailed geologic mapping had been completed in the adjacent quadrangles, this quadrangle was also selected for detailed mapping.

The field mapping and collection of mine data, gas well and diamond core drill records for the basis of this report was done by the author, practically unaided, in parts of the summers of 1936, 1937, 1938, and 1939. The area was revisited for a short time during the summer of 1944 to obtain additional data.

Work on the completion of the report had been interrupted at various times because the author was called upon to assist with other projects, particularly since the United States' entry into World War II, when the efforts of the staff of the Geologic Survey were directed almost entirely to investigation of strategic minerals. In fact much of the writing of the text, and the drafting of most of the accompanying illustrations were done on the author's own time.

Because it is the intent to emphasize the economic phase of the geology in this report, incidental scientific problems could not be studied in much detail, and are, therefore, rather lightly treated.

Previous Geologic Work

H. D. Rogers, State Geologist of the First Geological Survey of Pennsylvania, in his final report[1] made some reference to this area. The Second Geological Survey of Pennsylvania, which was established in 1874, published county reports which cover most of the State. Reports by W. C. Platt, designated H4, H5 and H6, on Indiana, Armstrong and Jefferson counties respectively, include this area. They describe the geology and mineral resources in some detail and are accompanied by geologic maps on a scale of one inch equals 2 miles. The field work for each of these reports was probably done in one season, and it may be assumed, therefore, that by covering so large an area in so short a time, the work could not have been much more than a reconnaissance and that errors would be made. This is particularly true with regard to the structure. The reports are, however, generally accurate and were useful in the preparation of this report.

Acknowledgements

I regret that it is impractical to mention by name all the companies and individuals who furnished valuable information for use in this report, but I am particularly grateful for the cooperation of Mr. Oldknow, chief engineer of the Buffalo and Susquehanna Coal Company; Mr. Pfahler and Mr. Erickson, engineers for the Berwind-White Coal Company; Mr. Coulter, chief engineer for the Clearfield Bituminous Coal Company; T. W. Phillips Gas and Oil Company; Peoples Natural Gas Company; Equitable Gas Company; Hoffman Bros. Drilling Company; Mr. John Shoffner, mining engineer at Kittanning, and Mr. Harry Walker, mining engineer at Punxsutawney.

I greatly appreciate the kind counsel of Dr. Geo. H. Ashley, State Geologist, and the suggestions of Dr. R. W. Stone, assistant State Geologist, who edited this report. Dr. R. M. Foose of the Geological Survey visited the author while in the field and assisted with the plane table work in the Big Run area.

[1] Rogers, H. D., Geology of Pennsylvania, vol. 2, p. 486, 1858.

GEOGRAPHY

Industries and Settlements

The first white man known to have visited this region was John Ettwein, a Moravian missionary, who, with a group of Christianized Indians, passed through in 1772 on his way to Ohio. The region was settled late in the 18th century by people of Scotch-Irish descent and later by Germans. These early settlers were hunters and trappers and subsisted mostly on the abundant wild life. Beginning about 1847, lumbering was the chief industry. Experienced lumbermen came from Maine and New York. When the timber was exhausted, interest turned to the large deposits of coal. With the development of this industry came immigrants from foreign countries, particularly Austrian, Italian, Polish, and Slavic people. Beginning about the close of the 19th century, the area included in this report was part of one of the more active coal mining districts in western Pennsylvania. The production of coal reached its highest level during the boom years following World War I and began to decline rapidly thereafter. The critical fuel shortage resulting from the entry of the United States into World War II, revived the industry. During that time much of the coal produced in this area was done by strip mining.

The natural gas industry is also important and large quantities of gas have been produced in this quadrangle. The field appears to have passed its prime although successful wells are still being drilled.

Up to and during the boom years of the coal industry, agriculture received little attention. Contemporaneous with the decline of the coal industry, much impetus was given to development of the agricultural resources, and in recent years the region is dominantly agricultural. Federal and State agencies have done much to aid the farmers with scientific methods. Strip-cropping, as a soil conservation measure, has been generally adopted. Many of the farms are equipped with modern machinery. The principal crops are corn, wheat, oats, buckwheat, rye, hay, and potatoes. Fruit growing is gaining favor. Dairy cattle, hogs, sheep, and poultry are the prevailing livestock.

The alluvium-covered flats along the larger streams afford the better soil for cultivation, but these are relatively small, disconnected areas; therefore, the major part of cultivation is on the uplands and gently sloping hillsides. The uncultivated areas are relatively small, and occur in the ravines, rock-strewn uplands, and the steep valley sides.

The soil of the Smicksburg quadrangle is predominantly of the Dekalb series. It is derived from all geological formations exposed in the quadrangle and occupies varied topographic positions. Some has been formed from materials weathered in place, some from materials removed from the uplands and deposited on lower benches, and some from similar materials deposited on the flood plains. The surface soils are gray, light-brown, or grayish-yellow and the subsoils are yellow, with occasional gray, yellow, and brown or gray and yellow mottling in areas occurring on lower slopes or in gently

Figure 2. Smicksburg, as seen from south.

sloping low-lying positions where drainage is not thoroughly established. The soil material is frequently 3 feet or more deep on lower slopes and over nearly level areas, but generally bedrock is encountered within the 3-foot section. The alluvial soil occurs on the flood plains of the larger streams.

All the settlements in the Smicksburg quadrangle are small rural and transient mining villages. A few of the communities that were flourishing when the mines were active have been deserted since the closing of the mines and are now "ghost towns." Punxsutawney (9,492)[2], the western limit of which is just included in the northeast corner of the Smicksburg quadrangle, is the coal and trade center of the region; Smicksburg (223), from which the quadrangle takes its name, is situated just west of the quadrangle center along Little Mahoning Creek; Dayton (882) is near the center of the west boundary; Sagamore, a typical mining town, is in the southwest corner; Marion Center (439) is in the southeastern part near a branch of the Baltimore & Ohio Railroad; and Timblin, Corbettown, Sunrise, and Dora are a cluster of small mining towns in the northwestern part along Pine Run. Other hamlets in the quadrangle are: Ringgold, New Salem, McGregor, and Milton in the northwestern part; Oliveburg, Sportsburg, Fordham, Valier, and Hamilton in the northeastern part; North Point, Loop, and Georgeville in the central part; Trade City, Covode, and Marchand in the eastern part; and Plumville and East Plumville (469) in the southwestern part.

Transportation

All parts of the Smicksburg quadrangle are accessible by an excellent system of paved roads. Most of these roads are macadam; some are modern concrete pavements. These roads are kept open by snow-plows during the winter months, and are particularly advantageous to farmers and small coal operators. One U. S. route, six State routes, and numerous unmarked "black top" or "Pinehot" roads traverse the quadrangle. U. S. Route 119 crosses the southeastern part of the quadrangle, interseeting U. S. Route 30, the Lincoln Highway, in the southern part of the State and connecting with Route 322, the Lakes-to-Sea Highway, at Du Bois to the north; Route 36 traverses the northeast corner of the quadrangle connecting Punxsutawney and Brookville; Route 210 joins U. S. Route 119 south of Punxsutawney and trends southwest to intersect Route 85 at Plumville, which latter route crosses the southwest corner of the quadrangle; Route 536 leaves Route 36 north of Punxsutawney and trends northwest; Route 954 starts on Route 210 at Trade City, goes west to Smicksburg, thence south to Plumville.

The quadrangle is well served with railroads. The Baltimore & Ohio Railroad, formerly the main line of the Buffalo, Rochester and

[2] Census of 1940.

Pittsburgh, was opened in 1893 and extended to Pittsburgh in 1898. This route and the Pennsylvania Division of the New York Central lines give aeeess to markets in eentral and western New York and in the New England States. The Baltimore & Ohio Railroad follows the valley of Mahoning Creek from Punxsutawney to Smicksburg station, where it leaves the creek, continuing overland through Dayton. A braneh of the Baltimore & Ohio starts east at Punxsutawney, enters the quadrangle in the valley of Little Mahoning, turns south at Pickering Run, and continues past Marion Center to Indiana. Another branch, formerly the Buffalo & Susquehanna Railroad, leaves the above braneh at Juneau, entering the Smicksburg quadrangle east of Covode, crosses the divide of Canoe Creek and Mudliek Run at a high grade and continues down Mudlick Run to the valley of Little Mahoning Creek, which it follows to Frantz. Here it crosses a low divide to Plum Creek, following it southwest to the mines at Sagamore.

A spur of the Pennsylvania Railroad enters the quadrangle from Punxsutawney and follows Mahoning Creek to Fordham.

The Pittsburgh and Shawmut Railroad enters the quadrangle about the center of the northern boundary, crosses Big Run, tunnels through the divide of Big Run and Pine Run and follows the valley of Pine Run westward. This is ehiefly a coal road from Brockway to Freeport. It has freight connections with the Baltimore & Ohio to Pittsburgh and direct connections with the Pittsburgh, Shawmut and Northern Railroad and the Erie Railroad to the lake ports and northern markets.

From Punxsutawney, bus service, which operates on regular sehedules, is available directly or indirectly to all large cities.

Climate and Vegetation

The elimate of this region is of the temperate type, the same as that of the greater part of western Pennsylvania. The change in temperature from one season to another is gradual. The spring season is more often characterized by extremes than the fall months, and is generally colder and more uneertain. The summers are generally pleasant and mild; brief periods of oppressively hot weather occur, but the nights are cool and refreshing. The winters are not continuously cold, and only occasional sub-zero temperatures occur. The areas of higher elevations average slightly eolder temperatures. Fogs oeeur through the year, being heaviest in the fall. The mean annual temperature is about 46.5°F.; the mean annual rainfall about 40 inches. U. S. Weather Bureau data from 1916 to 1938 indicate a total annual snowfall (unmelted) of 40 ineches, varying from 17.8 inches in 1919 to 54.4 inches in 1935. The average length of the growing season is 113 days. The following tables were taken from U. S. Weather Bureau's "Climatological Data" as reported by the Brookville Weather Bureau Station.

Monthly and annual mean temperatures in degrees Fahrenheit and precipitation in inches as recorded at Brookville are given in tables below:

*Monthly and Annual Mean Temperatures**

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Departure from normal
1916	31.1	21.9	26.0	b44.8	57.9	a60.0	a70.8	68.2	56.9	a48.1	37.6	26.4	45.8	----
1917	22.8	20.0	34.5	43.8	49.2	61.7	68.0	a66.4	55.4	a42.8	33.2	17.0	42.9	----
1918	10.8	23.9	----	44.0	61.2	60.9	65.7	69.4	f54.6	b50.9	a38.8	b34.0	----	----
1919	28.0	27.7	a36.6	44.8	54.4	68.6	b69.2	a64.0	60.4	e53.0	b37.4	e21.2	47.2	----
1920	a15.4	b20.5	d34.4	b40.2	52.8	62.8	64.8	b65.8	60.0	a53.2	a36.2	a29.5	47.1	----
1921	e26.8	e29.4	a43.3	50.4	a56.4	a65.7	71.7	63.8	65.3	b49.0	39.2	28.4	49.1	----
1922	21.6	28.8	35.8	a46.8	57.9	64.6	67.8	64.4	a62.4	50.3	39.2	27.4	47.2	+0.6
1923	26.0	21.3	32.0	a43.2	a53.0	a66.1	66.6	64.3	60.6	45.2	36.0	35.8	45.8	—0.7
1924	22.0	20.6	a33.0	42.2	----	61.0	a64.5	65.2	55.2	47.8	34.6	25.0	----	----
1925	18.4	a31.0	b35.5	b47.0	50.0	65.8	a65.1	b65.6	63.0	41.6	b34.7	----	----	----
1926	22.0	b23.6	28.2	b40.0	a53.9	58.9	66.0	68.0	b60.7	a47.7	b35.2	21.6	43.8	—2.7
1927	a23.2	b31.2	b37.6	43.0	b53.9	a58.2	b67.0	b60.7	b60.2	----	e43.6	27.0	----	----
1928	25.0	a21.6	31.1	b40.4	a53.0	61.6	b68.5	e70.1	a55.9	e51.3	38.6	30.2	45.9	—0.6
1929	22.3	22.5	38.6	b47.0	a52.2	----	e66.8	f60.8	e59.1	a45.5	a35.5	28.8	----	----
1930	24.8	30.8	31.8	----	e56.4	b63.5	b67.2	65.6	b63.0	a46.6	37.2	25.9	----	----
1931	a25.2	28.4	32.6	a43.8	53.8	62.9	a70.8	a67.4	65.2	50.8	45.4	34.9	48.4	+2.2
1932	37.6	b30.6	29.6	42.6	a54.4	63.4	a66.2	b65.0	b61.6	b50.9	35.9	28.0	47.2	+1.0
1933	32.9	a26.0	32.0	49.4	58.8	67.2	69.1	68.2	64.2	49.8	36.0	29.0	48.6	+2.4
1934	29.1	13.2	30.2	45.1	58.4	70.2	71.9	65.2	64.0	----	40.0	26.3	----	----
1935	22.8	23.2	37.8	42.9	50.6	63.2	71.6	67.6	57.8	47.0	39.3	22.4	45.5	—0.7
1936	----	----	----	----	----	----	----	----	----	----	----	----	----	----
1937	32.9	27.6	a29.8	44.4	59.7	64.6	68.5	70.6	56.8	46.7	e36.0	25.0	46.9	+0.5
1938	24.8	31.5	37.4	46.0	54.9	62.5	68.2	70.6	61.1	58.8	----	31.6	----	----
1939	24.8	26.2	30.6	39.8	59.6	64.5	66.2	----	59.0	48.6	34.6	30.7	----	----
1940	13.8	22.8	26.8	43.2	52.4	62.9	65.3	59.9	----	----	37.5	32.0	----	----

* U. S. Weather Bureau "Climatological Data."
Letters of alphabet denote number of days missing.

*Monthly and Annual Precipitation**

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Departure from normal
1916	3.72	2.38	3.61	2.99	4.18	6.91	2.10	1.03	4.36	2.84	2.26	1.23	37.61	—2.63
1917	2.71	—	1.43	0.66	4.04	5.00	2.97	2.15	1.39	6.98	0.48	1.56	—	—
1918	2.64	1.72	—	—	—	4.95	2.93	4.00	2.65	1.45	0.92	1.70	—	—
1919	—	2.95	3.32	2.38	6.85	2.96	2.38	6.80	2.49	6.40	2.71	2.24	—	—
1920	3.02	2.30	1.65	—	1.54	5.97	3.59	3.02	4.53	1.55	3.31	2.91	—	—
1921	3.04	1.41	4.49	1.53	2.20	2.95	5.36	4.30	7.96	2.52	6.21	3.16	45.13	+5.17
1922	1.62	1.47	5.28	4.78	1.70	2.78	1.96	3.79	0.58	2.28	1.59	4.32	32.15	—7.89
1923	4.00	2.20	1.43	1.17	4.77	2.17	3.03	3.29	1.77	1.41	2.85	5.59	33.68	—6.63
1924	4.55	2.37	2.39	3.62	—	5.09	3.59	3.54	6.48	0.31	0.96	2.64	—	—
1925	3.07	2.10	2.31	1.43	3.80	2.85	2.68	0.94	2.71	3.30	5.39	—	—	—
1926	1.85	1.34	—	0.85	1.13	5.05	1.49	6.59	5.75	4.59	2.40	3.16	—	—
1927	3.85	3.14	3.35	2.95	4.70	3.85	3.90	3.20	1.88	—	5.85	6.20	—	—
1928	1.45	2.73	3.25	4.20	1.75	9.81	4.85	4.35	2.37	3.67	5.23	1.43	45.09	+4.78
1929	4.42	2.94	3.41	6.37	6.00	—	5.05	0.50	2.55	7.39	3.40	3.36	—	—
1930	4.69	2.50	3.18	4.03	2.20	3.31	3.56	0.62	1.55	0.96	1.76	1.90	30.26	—10.05
1931	1.08	2.22	2.21	3.88	4.89	4.88	4.60	1.92	3.11	1.46	2.47	5.02	37.74	— 2.15
1932	7.48	1.49	2.29	2.31	2.42	3.24	4.55	1.66	1.84	3.63	4.43	3.09	38.43	— 1.27
1933	1.58	2.16	5.29	3.69	5.82	2.71	2.77	3.88	2.47	1.72	3.20	4.02	39.31	— 0.38
1934	2.61	1.20	2.59	2.19	0.96	3.68	4.49	6.05	3.33	2.36	3.79	2.30	35.55	— 4.21
1935	3.78	2.92	2.43	1.61	4.72	4.74	9.60	6.00	3.15	2.05	2.87	3.85	47.72	+ 7.96
1936	3.27	2.21	8.43	3.11	2.94	2.49	3.61	4.85	1.61	4.92	3.82	4.61	45.87	+ 6.29
1937	8.57	2.36	2.10	7.01	4.22	5.33	4.01	3.52	2.41	5.01	2.02	4.45	51.01	+11.43
1938	3.63	3.85	5.02	4.74	4.12	6.04	4.49	2.02	3.35	2.02	3.18	1.83	44.29	+ 4.71
1939	3.47	4.77	5.45	3.07	1.47	3.27	4.46	2.60	2.59	3.90	1.17	3.22	39.44	— 0.14
1940	1.89	3.66	4.37	5.61	4.03	5.04	2.18	2.31	3.49	0.85	4.34	4.14	41.91	+ 2.33

* U. S. Weather Bureau, "Climatological Data."

Climatological Data—Brookville Weather Bureau Station

Year	Length of record in years	Temperature (degrees Fahrenheit)						Precipitation (inches)								Sky		
		Annual mean	Highest	Date		Lowest	Date	Length of record in years	Total for year	Greatest monthly	Month	Least monthly	Month	Total snowfall unmelted	Number of days with .01 or more	Clear days	Partly cloudy days	Cloudy days
1916	6	45.8	98	Aug.	21	—26	Mar.	18	26	37.61	6.91	June	1.06	Aug.	52.9	98			
1917	7	42.9	96	July	31	—26	Feb.	13	27								172	106	84
1918	8		100	Aug.	6	—32	Feb.	5	28										
1919	9	47.2	96	July	5	—14	Dec.	17	29		6.85	May			17.8		198	83	72
1920	10	47.1	89	June	11	—20*	Jan.	4	30		5.97	June	1.55	Oct.	40.4		191	103	60
1921	11	49.1	96	July	5	—10	Jan.	26	31	45.13	7.96	Sept.	1.41	Feb.		111			
1922	12	47.2	94	July	11	—15	Jan.	25	32	32.15	5.28	Mar.	0.58	Sept.		92			
1923	13	45.8	101	June	24	— 5*	Feb.	7	33	33.68	5.59	Dec.	1.17	Apr.	33.5		223	58	84
1924	14		92	Aug.	6*	—23	Feb.	24	34				0.31	Oct.	48.5				
1925	15		97	Aug.	31	—27	Jan.	28	35										
1926	16	43.8	96	July	21	—19	Jan.	29	36										
1927									No data										
1928	17	45.9	93	Aug.	3	—13	Jan.	30	38	45.09	9.81	June	1.43	Dec.	35.0	103	197	88	81
1929	18					—20*	Jan.	16	39				0.50	Aug.	49.5				
1930	19		100	Aug.	4	—23	Jan.	26	40	30.26	4.69	Jan.	0.62	Aug.	36.9	119	217	65	83
1931	20	48.4	98	July	3	— 9	Jan.	2	41	37.74	5.02	Dec.	1.08	Jan.	27.5	122	196	56	113
1932	21	47.2	98	Sept.	2	—14	Dec.	16	42	38.43	7.48	Jan.	1.49	Feb.		126	206	48	112
1933	22	48.6	101	July	24	—16	Feb.	13	44	39.31	5.82	May	1.58	Jan.	53.0	124	138	85	142
1934	23		98	July	26	—30	Feb.	28	45	35.55	6.05	Aug.	0.96	May	38.4	114	131	123	111
1935	24	45.5	95	July	20	—13	Dec.	29	46	47.72	9.60	July	1.61	Apr.	54.4	150	108	98	159
1936	25	45.5	100	July	10	—27	Feb.	20	47	45.87	8.43	Mar.	1.61	Sept.		171	82	107	177
1937	26	46.9	92	July	9	—12	Dec.	14	48	51.01	8.57	Jan.	2.02	Nov.	32.7	166	89	89	187
1938	27		96	Aug.	15	— 3	Jan.	28	49	44.29	6.04	June	1.83	Dec.		160	78	102	185
1939									No data available										
1940									No data available										

* Other days also.

Killing frosts or freezing temperature

Year	Last in spring	First in autumn	Year	Last in spring	First in autumn
1926	June 4	October 8	1933	June 15	October 3
1927	June 16	September 20	1934	May 27	August 30
1928	June 11	September 24	1935	May 26	September 11
1929	May 25	September 18	1936	May 31	September 2
1930	June 1	August 12	1937	May 21	September 18
1931	June 3	September 30	1938	May 25	September 26
1932	June 9	September 9	1939	May 15	September 18
			1940	May 11	September 26

Practically all the virgin timber has been cut from this region. The original forest growth consisted of white, red, black and chestnut oaks; hickory, poplar, sugar maple, walnut, locust, birch, cucumber, and dogwood, with pine and hemlock in the more rocky places. The remaining second growth timber mainly occurs on the valley sides, steep hills, and the uplands where the surface is scattered with debris from resistant underlying sandstones. Some of this second growth timber is cut for mine props. The undergrowth is heavy and consists of laurel, huckleberry, dewberry, goldenrod, blackberry, ground pine, and wintergreen; rhododendron grows on the lower slopes of the V-shaped valleys. Owing to the climate, which greatly stimulates plant growth, land cleared of timber and farms left uncultivated for a few seasons become dense thickets of weeds and briers.

PHYSIOGRAPHY

General Relations

Based on the classification by Fenneman[3], the topography of Pennsylvania falls within six physiographic provinces (fig. 3). They are, from east to west, as follows: The Coastal Plain Province, the Piedmont Province, the Greater Appalachian Valley Province, the Appalachian Mountain Province, the Appalachian Plateau Province, and the Central Lowland Province. These provinces are subdivided into sections.

Western Pennsylvania is in the Appalachian Plateau Province which covers a broad belt extending from the Adirondack Mountains in New York to northern Alabama, and between the Allegheny Mountains in the east (where it terminates in a well-developed escarpment called the Allegheny Front) and the Central Lowlands in the west into which it gradually merges. This province in the State is subdivided into five sections: the Lake Erie Plain, the glaciated sections in the northeast and northwest, the Allegheny High Plateau in the north and the Pittsburgh section in the south.

[3] Fenneman, Nevin M., Physiographic divisions of the United States: Annals Assoc. of American Geographers, vol. 18, no. 4, Dec. 1928.

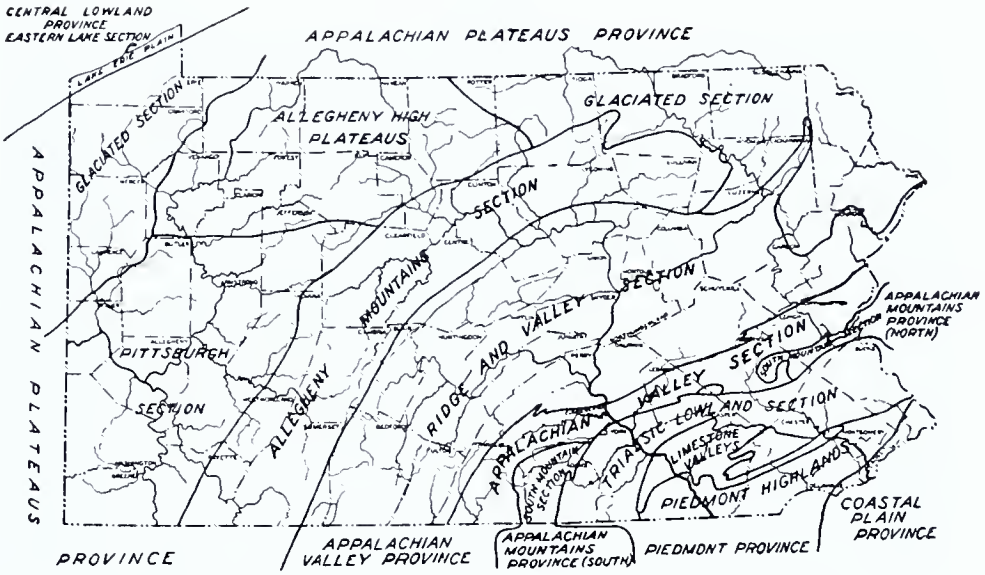

Figure 3. Physiographic subdivisions of Pennsylvania.

Figure 4. Gorge of Mahoning Creek at west boundary of the quadrangle looking upstream.

Relief

The Smieksburg quadrangle is in the Pittsburgh seetion of the Appalachian Plateau province. The topography eonsists of steep-sided valleys that range from narrow to wide bottoms. The angle of slope is controlled by the relative hardness of the roeks through whieh the streams have eut. Northwest of Milton, where Mahoning Creek has cut through hard sandstones, the valley walls are nearly precipitous. The upland is part of a broad, disseeted plateau, approximately mature; its surface includes rounded hilltops where underlain by shale, and nearly flat-topped areas where underlain by sandstone. When a broad expanse of the upland is viewed from any of the high elevations, a general uniformity of these hilltops will be noted. This is a striking eharaeteristic, indieating that this region has been redueed by erosion to a nearly level surfaee or peneplain[4], and, later, had been uplifted and disseeted.

The elevation of the hilltops above sea level ranges from about 1,400 feet to over 1,800 feet, and averages about 1,600 feet. This difference may be aeeounted for mainly by differential erosion. The highest point in the quadrangle is a hill contoured at 1,840 feet, about one mile northwest of Grange. The lowest point, contoured at 1,050 feet[5], is the gorge of Mahoning Creek where it leaves the quadrangle. The greatest relief or differenee in elevation between hilltop and adjaeent valley is about 540 feet and oeeurs northwest of Grange.

Ashley[6] had ealled this upland surfaee the Allegheny peneplain and tentatively eorrelated it with the Chambersburg peneplain[7] of southeastern Pennsylvania. Further study, however, east some doubt upon this, and (for the present) it will be referred to as the Allegheny surfaee.

[4] Peneplain means almost a plain; a surface nearly reduced to base-level by long erosion, and indicated by remnants of concordant hilltops.

[5] From levels of U. S. Engineers.

[6] Ashley, G. H., Scenery of Pennsylvania: Pa. Geol. Survey Bull. G6, p. 23, 1933.

[7] Campbell, M. R., Chambersburg (Harrisburg) peneplain in the Piedmont of Maryland and Pennsylvania: Bull. Geol. Soc. Am., vol. 44, p. 553-573, June 1933.

Figure 5. Topography, southeast of Ringgold.

Drainage

The Smicksburg quadrangle lies west of the eastward drainage divide of Pennsylvania, hence the master streams flow generally westward and, eventually, into the Allegheny River. Mahoning and Little Mahoning Creeks are the largest streams and drain most of this area.

Mahoning Creek has its source in southern Jefferson County. It flows westward across the north-central part of the quadrangle in a winding course, with many pronounced ox-bows, as those at Valier, Loop, and Milton. The quadrangle is 13 miles wide but in crossing it the creek flows 27 miles. The gradient east of the axis of the Sprankle Mills anticline is about 5 feet per mile; west of the axis it is 14 feet per mile. The creek drains 71 square miles of the quadrangle.

Little Mahoning Creek rises in northern Indiana County. It enters the quadrangle at the southeast, flows northwestward and joins Mahoning Creek northeast of Dayton. Its course, though winding, is more direct than Mahoning Creek. What is probably an abandoned meander occurs at Rossmoyne. About 61 square miles of the central and southern parts of the quadrangle are drained by this stream.

Pine Run rises in the north-central part of the quadrangle, and drains about 25 square miles of the northwestern part. Flowing westward, it joins Mahoning Creek at Eddyville in the Rural Valley quadrangle.

About 13 square miles of the northeastern part of the quadrangle are drained by Big Run, which flows northwestward into the Brookville quadrangle, where it empties into Little Sandy Creek.

Cowanshannock Creek, Plum Creek, South Branch of Plum Creek, and Pine Run flow southwestward and drain about 55 square miles of the southern part of the quadrangle.

The larger streams have an economic bearing on the region. In creating their valleys, they have exposed the edges of valuable coal beds, limestones, and clays, and have afforded ways of communication with the surrounding country by means of roads and railroads, which, in turn, make accessible the mineral resources. The flood plains are cultivated and are the site of some villages.

The volume of water in the streams varies with the seasons. During the summer months, they reach their lowest levels and in times of drought are nearly dry. In the springtime, flood stages are not uncommon. Mahoning Creek, in March 1936, reached an unprecedented flood stage and caused considerable property damage. The valleys of Mahoning and Little Mahoning Creeks are now the reservoir of a flood control dam located in the gorge of Mahoning Creek near McCrea Furnace about 1¼ miles west of the Smicksburg quadrangle. Following are the data on Mahoning Dam:

Type—concrete gravity
Purpose—flood control
Length of dam—993 feet
Cost—approximately $6,870,000
Length of spillway—192 feet
Five crest gates, 30 feet wide and 29 feet high
Two traveling gantries, one with derrick for hoisting gates
Drainage area above dam is 341 square miles

Storage capacity at full level is 244 billion gallons (?)
Area of reservoir at full level is 2,370 acres
Concrete—318,000 cubic yards
Minimum stream level—1,075 feet
Full reservoir level—1,162 feet
Stream bed to spillway crest is 125 feet
Spillway crest to top of dam is 35 feet

Summary of Geologic History

The series of geologic events that determined the physiography or character of the present surface of this region began in early Cambrian time and continued to the close of Carboniferous time (550-200 million years ago). During this time the Appalachian geosyncline, a long, narrow trough that extended across eastern North America from the Gulf of Mexico to the Gulf of St. Lawrence, was, for the most part, covered by a vast inland sea, similar to Hudson Bay, in which the rocks underlying this region were deposited as a series of sediments. These sediments were received from a positive area or large continental land mass, called Appalachia, which bordered on the southeast. The sea floor was slowly depressed as it became filled with these sediments, and the land at the east rose and was eroded. At the end of Carboniferous time, approximately 30,000 feet of sediments had accumulated east of the Allegheny Mountains, but were progressively thinner westward. The nature of the sediments, such as mud, sand, limy material, clay, and coal, varied with changing conditions. Accumulation was not continuous, but interrupted by recurrent uplifts which often raised the ocean bottom above sea level. Some of the newly laid sediments were thus eroded, and later sediments, deposited in the area when it had again subsided, were laid unevenly upon the eroded surfaces. These unconformities are partly responsible for the irregularities in the rocks of the Conemaugh and Allegheny groups in this quadrangle. Toward the end of this long period of deposition conditions became more stabilized near sea level and vast swamps in which thick layers of plant remains accumulated, covered the area. Subsequent intermittent periods of deposition allowed the accumulation of more sediments upon this vegetable matter. These layers were compressed and consolidated by the weight of the overlying material.

Near the end of Carboniferous time an historic event occurred which the geologist calls the Appalachian Revolution. Mountain-making forces from the southeast pushed the essentially flat-lying beds, crushing, overturning, and overthrusting them in eastern Pennsylvania, but only slightly folding them into gentle anticlines and synclines in this area and elsewhere in western Pennsylvania. This left the region above sea level.

During and following the folding, erosional processes of weathering and stream action were active and reduced the land to an almost featureless surface, or peneplain. It was on this plain that the present main drainage channels of the area were established, such as Mahoning and Little Mahoning Creeks. Their meandering courses suggest that they were developed on a nearly level surface.

The final plain from which, when uplifted, the present surface features were carved, probably dates from late Tertiary time, about 30 million years ago. This regional uplift was gradual and without folding or faulting of the rocks. The rejuvenated streams renewed the process of down-cutting but maintained their original courses. Today they are deeply entrenched hundreds of feet below the old peneplain which is reflected by concordant hilltops.

Relation of the Geology to the Topography

The geology of the region bears some relation to the general character of the topography. The slope and configuration of the hills are, to a large degree, controlled by the nature of the underlying rocks. Thus, where the hills are underlain by shale, they tend to be evenly rounded, and the slopes are gentle. This condition is well shown in the area between Sagamore and Marion Center. Here the hills are predominantly composed of shale of the lower Conemaugh group. Where the surface is capped by sandstone, the hilltops are somewhat higher, nearly flat-topped, and the slopes are moderately steep, as may be seen on the upland north of Porter, where the Mahoning sandstone is well developed, and in the vicinity of Marchand, which area is underlain by the Saltsburg sandstone. A series of alternating shale and sandstone ledges will give a hillside a terraced effect, the same as a succession of coal beds with underclay and associated shales.

Figure 6. Upland, looking south toward Marchand.

In general, the streams in the quadrangle have maintained their courses regardless of the structure, indicative that downcutting by the streams kept pace with the forces deforming the rocks. This condition is notable northwest of Milton where Mahoning Creek has entrenched its channel across the Sprankle Mills anticline. There are, however, indications that the structure and the stratigraphy may have influenced some local physical features, particularly along Mahoning and Little Mahoning Creeks. Looking at the Rural Valley quadrangle,

it will be noted that Mahoning Creek is entrenched in a steep-sided valley with scarcely any flood plain; whereas, in the Smicksburg quadrangle, and east of the Sprankle Mills anticline, Mahoning and Little Mahoning Creeks have relatively wide flood plains. The anticline crossing Mahoning Creek above Milton has elevated hard sandstones of Pottsville and Pocono age. When the creek encountered this more resistant material, downcutting in that locality was appreciably retarded, thus affording opportunity for Mahoning and Little Mahoning Creeks, both still cutting in softer rocks, to widen their valleys and aggrade the resultant flood plains.

Referring to the mineral resources map (pl. III), it will be noted that at Loop the structure contours, in a general way, simulate the bends of Mahoning Creek. Also, north of McCormick, Little Mahoning Creek turns abruptly southward from its general northwest course as the stream encounters a dome on the axis of the Plumville anticline, and resumes its general trend around the southwest plunge of the dome. Considering the hypothesis that these are antecedent streams and were superposed on a relatively flat surface whereon their original channels were established, these phenomena may be only coincidental. On the other hand, it does not preclude an inference that the structure and the stratigraphy were at least contributing factors in deflecting the courses of these streams locally.

The occurrence of the highest elevation in the quadrangle near a dome on the Sprankle Mills anticline, west of Grange, is probably due to the fact that that area is relatively far from the main streams. Further evidence supporting this theory is that the hilltops become lower toward Mahoning Creek.

The anticlinal theory (originated by I. C. White) which states that oil and gas tend to accumulate in structural highs, has confused some oil and gas operators who believed that high land reflected structural highs, and the valleys structural lows. Frequently, the reverse is true.

The Topographic Map

The topographic map (pl. I) is based on the determined position of some of the prominent hilltops of the area, known as triangulation stations. One of these is located just southeast of McGregor at an elevation of 1,707 feet above sea level. These positions have been determined by triangulation connecting with astronomical stations at Washington, D. C., Cumberland, Md., Grafton, W. Va., and Pittsburgh, Pa., and the accuracy of the work has been checked by carefully measured base lines. The details of the map have been worked out by plane-table triangulation and surveyed lines along the roads, railroads, ridges, and elsewhere. The methods by which such maps are made are described in U. S. Geological Survey Bulletin 788, Topographic Instructions, and a description of the triangulation stations and level lines is given in Appendices A and B. The Smicksburg map was surveyed in 1906-1907, and the culture was revised in 1938.

Topography includes the physical features or land forms, their shape, altitude, and sculpture. This is represented on the map by brown lines. The streams are depicted in blue. The culture, or works

of man, consisting of roads, railroads, towns, county and township boundaries, is shown in black; main highways are colored red.

For those unfamiliar with, and unaccustomed to using a topographic map, the following brief explanation of the contour lines may be helpful. Unlike many maps, on which the configuration of the surface is shown in a pictorial way by use of hachures or by shading, contour lines represent the surface in more or less mathematical accuracy. These are somewhat parallel lines of equal elevation. The interval between the lines is 20 feet, which means that along any given contour on the map the surface is 20 feet higher than the surface along the line below. Every fifth line is a 100-foot contour and is drawn heavier than the intermediate lines. Where the lines are close together, the slope is steep, and where they are far apart, the slope is gentle. The elevation of any point lying between two contour lines can be approximately determined: For example, if an object is located between the 1,200- and 1,220-foot contour, it is assumed that its elevation is somewhere between 1,200 and 1,220 feet, and it may also be assumed that its elevation is nearer one or the other of those figures in proportion as it is nearer one or the other of those lines. It is, therefore, possible, from the map, to estimate the elevation of a given point, such as a mine or a house, within about 5 or 10 feet. It is not, however, always safe to assume so close a figure. Where accuracy is desired, it would be necessary to run levels from a known elevation to the point at which the elevation is sought.

STRATIGRAPHY

General Description

All the exposed strata, and the strata penetrated by drilling in this region, are in one of the major divisions of the earth's rocks, called the Paleozoic, which means "ancient life." These strata are so named because they contain fossil remains of plants and animals, now extinct, which differ greatly from the flora and fauna of later geologic time. The Paleozoic formations are subdivided into five systems, and named in the following ascending order: Cambrian, Ordovician, Silurian, Devonian, and Carboniferous. A modification of this classification follows: Cambrian, Ozarkian, Canadian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, and Permian systems. In this quadrangle the subsurface rocks have been pierced by drilling to the upper part of the Devonian. The exposed rocks are all Carboniferous ("Age of Coal") and are included in the Pennsylvanian and Mississippian systems.

General character of the rocks. A total thickness of about 1,000 feet of rocks is exposed in this area and about 6,000 feet of the underlying rocks have been penetrated by drilling. These rocks are sedimentary in origin. No igneous or metamorphic rocks were found in this quadrangle. The rocks consist of shale, sandstone, conglomerate, limestone, clay, coal, and a few thin beds of impure iron ore; shale

and sandstone predominate. All these rocks are stratified, i. e., lie in layers like those of a cake. They grade from massive, coarse-grained sandstones, which are locally conglomeratic, to thin and fissile shales. With the exception of small amounts of silt, sand, and gravel, which occur on the flood plains of the larger streams, and are of recent origin, and coal which accumulated under swamp conditions, these beds were deposited as sediments in an inland sea. Some of the limestones, such as Vanport limestone of the Allegheny group and the Brush Creek and Ames limestones of the Conemaugh group, are definitely marine and contain marine fossils. These strata differ from each other because of the varying conditions at the time of deposition. Deposited sand has become sandstone, muds have become shale, and limestone was formed from the accumulation of shells of marine life, algal growth, and by chemical precipitation. Coal is the result of the accumulation and partial decomposition of vegetation in ancient swamps.

Variable character of the rocks. Detailed studies of the stratigraphy in this region, and in other parts of western Pennsylvania, reveal that the strata are decidedly variable; this is quite typical of the "Coal Measures." Not only do the thicknesses of the respective formations vary, but the nature of the individual members changes from place to place. For instance, a thick, massive sandstone may within a short distance become thin and shaly, or grade into shale. Definite key beds such as coal and limestone may be discontinuous, and their places be occupied by other material. Regionally, however, the groups, and members within the groups, maintain similar characteristics; the Pottsville is predominantly composed of sandstone; the Allegheny contains many workable coal beds; and the Conemaugh is chiefly shale with sandstones and a few thin coals. The local irregularities are due to shifting and acceleration in velocity of currents and other factors, which caused changes of the material being deposited. The absence of a member at its expected horizon, such as a coal bed, may be accounted for by non-deposition, or by deposition and erosion. The abrupt disappearance, or "faulting" of a coal bed, which is common in the mines, is due to erosion.

Difficulty of mapping. It can be readily understood, from the above description, that the work of correlation and mapping in the field was very difficult. Further increasing that difficulty was the scarcity of natural and unweathered outcrops. Many of the valley sides, ravines, and hills are covered with debris from sandstones above; and where the underlying rocks are composed of shale, a variable thickness of residual soil covers the surface. Roads on steep hills, where one would expect to obtain a good section, are often disappointing in that they furnished only fragmentary data.

The stratigraphic chart. Because of the extreme variability of the members composing the groups of the Carboniferous, it was found impractical to draw one generalized columnar section for the whole area, and to attempt to do so would only result in confusing the reader.

PLATE 4. STRATIGRAPHIC SECTIONS IN THE SMICKSBURG QUADRANGLE SHOWING THE SEQUENCE AND VARIABILITY OF THE STRATA.

The sections shown on plate 4 are constructed from sections measured on the surface and from records of diamond drill holes. They are intended to show the variability of the strata locally and from place to place, and to show also the range in interval between the various members. The names customarily used to designate the members are shown at the left on the stratigraphic chart. The accompanying sketch map shows the location of the district which each section represents; and the explanation gives the meaning of the pattern used to depict the various kinds of rock.

QUATERNARY DEPOSITS

The Quaternary deposits of this region are Recent in age, and are of little consequence. They consist of thin and unconsolidated deposits of silt, sand, and gravel which have not been transported far from their source, and occur in the beds and on the flood plains of the larger streams. This material in the stream beds is usually unassorted, but on the flood plains it commonly consists of a fine loamy soil, excellent for farming.

PENNSYLVANIAN SYSTEM

It is fitting that the Pennsylvanian system should be named for this State because it was here that these strata were first studied and the sequence worked out, and also because of the economic importance of the coal beds. For convenience of study and mapping, the Pennsylvanian system has been subdivided into four groups named in descending order: the Monongahela, Conemaugh, Allegheny, and Pottsville. In plate II it will be noted that all of the Monongahela (if deposited) and the upper part of the Conemaugh have been eroded from this area, and that the rocks representing the Pennsylvanian in the Smicksburg quadrangle are as follows: Conemaugh, approximately 500 feet, uneroded, Allegheny 330-370 feet, and Pottsville ±150 feet.

CONEMAUGH GROUP

General Description

The Conemaugh group takes its name from the type locality along the Conemaugh River in southwestern Cambria and northeastern Westmoreland Counties where these rocks are well exposed. The Second Pennsylvania Geological Survey called it the "Lower Barren Coal Measures" because of the thin and non-persistent coal beds contained in it, and from what was observed of the coals in the group in this region, it certainly warrants such a designation.

The limits of the group extend from the top of the clay underlying the Pittsburgh coal downward to the top of the Upper Freeport coal. On the areal geologic map, plate II, it will be seen that rocks of the Conemaugh group occur throughout nearly all the quadrangle. They comprise the main body of rocks outcropping in the southern part. Remnants of the lowest members cap most of the hilltops in the northern part, but at some places the group is entirely removed; notably in the northeast, on and near the axis of the Sprankle Mills anticline.

The thickness of the group increases from about 600 feet in the Pittsburgh area to 700 feet in the region of Greensburg, and 900 feet toward the Allegheny Front. About 650 feet was reported from Armstrong County, and probably that much, or more, was deposited in the area covered by this report. At the present time, the thickness ranges from zero to an uneroded thickness of about 500 feet, which occurs in the southwestern part of the quadrangle.

The group is predominantly composed of shales that are usually sandy, with sandstones replacing the shales locally. Definite horizons are, however, characteristically sandy, while others are shaly. It may be stated with safety that sandstone occurs locally throughout the entire section. The sandstones are locally massive and coarse grained, with lenses of conglomerate. At some places they are so massive and resistant that they weather out into boulders up to 10 feet in greatest diameter. They also cause the nearly flat uplands. These sandstones megascopically have no distinguishing characteristics, and occasionally coalesce with those above and below. They are, therefore, uncertain stratigraphic markers. Red shales that occur throughout the section are commonly associated with limestones, and are helpful in locating the limestone horizons. The coals have little economic value, as they are generally thin and of poor quality, and at places are entirely lacking. Locally, however, they attain a thickness of a little over 2 feet and are mined for local consumption. The limestones are thin, impure and discontinuous; the average thickness is about 1 foot, the maximum being about 4 feet. These limestones are the main horizon markers, but are so deeply weathered that only a few outcrops of nodules were found.

The principal members of the Conemaugh group found in the Smicksburg quadrangle have approximately similar stratigraphic positions in the section, and some of the limestones have lithologic characteristics similar to those in other regions, and will be treated, herein, as those equivalents. Two limestones that appear to be reworked material, were observed. The principal members of the Conemaugh group occurring in the Smicksburg quadrangle in their order from top downward are as follows:

Morgantown sandstone and Birmingham red beds
Grafton sandstone
Duquesne coals
Ames limestone
Harlem coal
Pittsburgh red beds
Upper Saltsburg sandstone
Upper Bakerstown coals
Woods Run limestone
Lower Saltsburg sandstone
Lower Bakerstown coals
Meyersdale red beds
Pine Creek limestone
Buffalo sandstone
Brush Creek limestone and coals
Mahoning upper sandstone
Mahoning coal and limestone
Mahoning lower sandstone and shale

Morgantown sandstone and Birmingham red beds. The Morgantown sandstone and the Birmingham red beds are, stratigraphically, the highest members of the Conemaugh group recognized in the quadrangle. The Morgantown sandstone, which was named by J. J. Stevenson from its exposures in the vicinity of Morgantown, W. Va., caps the hill northeast of Barnards, upon which is located a triangulation

station whose elevation is 1,588 feet. This sandstone is loosely cemented and is deeply weathered to a medium-grained sharp sand. A pit at this location indicates that the sand was once dug here. The base of the sandstone appears to be about 415 feet above the Upper Freeport coal horizon. About 20 feet below the sandstone, fragments of red shale and earthy hematite were found, which probably represent the Birmingham red beds. The Wellersburg coal, which occurs between the Morgantown sandstone and the Birmingham red beds at some places in western Pennsylvania, appears not to be present at this locality in the Smicksburg quadrangle.

Grafton sandstone. Fragments of a shaly and thin-bedded sandstone of undetermined thickness were noted on the hill above the outcrop of the Ames limestone east of Plumville (Cf3)[8]; and a similar sandstone occurs above the outcrops of the Duquesne coal and Ames limestone east of Denton (Be2, 3). The stratigraphic position of the sandstone corresponds to the position of a sandstone mapped as the Grafton in other regions of western Pennsylvania.

Duquesne coal. The Duquesne coal, also called Barton and Elk Lick, occurs between the Grafton sandstone and the Ames limestone. It has a mineable thickness at some places in western Pennsylvania. In the Smicksburg quadrangle, it appears that at least three coals occur between the beds that delimit the Duquesne coal. These coals commonly are thin and non-persistent, but locally have attained a reported thickness of over 2 feet, and attempts have been made to work them for house coal; however, all openings were abandoned. The coals range up to about 50 feet above the horizon

[8] Reference datum on mineral resources map, plate III.

Figure 7. Duquesne coal in cut on U. S. Route 119, south of Sportsburg.

of the Ames limestone, or, from about 320 to 370 feet above the Upper Freeport coal horizon. Commonly associated with the coals are olive, buff, and gray to black shales with thin lenses of sandstone and impure clay.

The Duquesne coal is 3 to 8 inches thick and is about one foot above the Ames limestone in a cut along U. S. Route 119, south of Sportsburg (Fc5). See section below. One of the Duquesne coals had been worked northwest of Denton (Bd15), and was reported to be over two feet thick; a coal three inches thick and 29 feet above the Ames limestone crops out on the road between Denton and Crossroads School (Be3). See section below. Southeast of Georgeville, three thin coals (Ee4, 5, 8-12) occur at approximately 320, 345 and 365 feet, respectively, above the Upper Freeport coal horizon. The Ames limestone, if present, is not exposed in this locality, but its horizon is about 310 feet above the Upper Freeport in this area. These coals are, therefore, considered to be above the Ames limestone horizon, and within the range of the Duquesne coal.

Ames limestone. The Ames limestone is called the "Crinoidal limestone" in the reports of the Pennsylvania Second Geological Survey, because it commonly contains many broken crinoid stems, which, because of their resistance to weathering, project from the weathered surface, giving it a rough appearance. The limestone occurs about the middle of the Conemaugh group and is reported as having the highest stratigraphic position of any of the marine limestones occurring in western Pennsylvania.

In the Smicksburg quadrangle the Ames limestone occurs from 310 to 350 feet above the Upper Freeport coal horizon and averages about 18 inches thick. It compares favorably with the descriptions of it in other regions, being greenish-gray, hard, compact, breaking with a subconcoidal, hackly fracture, and usually very fossiliferous. Associated with the limestone are olive, greenish, drab, and dark shales, with interbedded red shales and lenses of sandstone. Because this bed is so easily identified, it is an important horizon marker, but it was found only at a few places on the high hills in the synclines where that part of the group is still preserved. The best exposure found is on the road near the hilltop between Denton and Crossroads School (Be2), where the limestone is 29 inches thick, typically greenish-gray, and fossiliferous. The following section shows the limestone and associated beds:

Section between Denton and Crossroads School

	Ft.	*in.*
Sandstone, Grafton	10	
Coal, Duquesne	0	3
Sandstone	9	0
Shale, olive, with interbedded red shale	20	0
Limestone, Ames, greenish-gray and fossiliferous	2	5
Shale, light, with lenses of sandstone	20	0
Shale, carbonaceous (Harlem coal horizon)	0	5
Clay shale	11	0
Shale, purplish-red		

The following section of the Ames limestone and associated beds is exposed about two miles east of Plumville, just north of B.M. 1332 (Cf3):

Section north of B.M. 1332	*Ft.*	*in.*
Shale and sandstone	15+	0
Shale, olive	10	0
Limestone, Ames, greenish-gray and fossiliferous	2	0
Shale, drab and olive	27	0
Coal, Harlem	0	6
Shale, light	21	0
Shale, purplish-red	1	0
Shale	15	0
Shale, brick-red, with light plastic fire clay	2+	0

In the cut on U. S. Route 119, about one mile south of Sportsburg (Fc5), the following section was obtained which shows the Ames limestone with its typical greenish-gray color, but fossils are lacking. The red beds are also lacking in the section.

Section south of Sportsburg	*Ft.*	*in.*
Sandstone, thin-bedded	3	0
Shale, drab	5	
Shale, black and fissile	1	8
Coal	0	3
Clay, greenish-gray to dark gray	1	2
Limestone, Ames, greenish-gray, with minute dendrites	1	0
Clay, dark	5	0
Shale, bluish-gray, sandy and micaceous	1	

Figure 8. Ames limestone in cut on U. S. Route 119, south of Sportsburg.

On the improved road between Barnards and Dayton, about half a mile north of Barnards, the Ames horizon is exposed in a cut (Ae1), but the section is so badly slumped that measurements could not be made. The section does, however, appear to be composed of shale with interbedded red shales. Blocks of limestone found on a near-by "fill" were typically greenish-gray, highly fossiliferous, and measured one foot thick.

Fossils in the Ames limestone in this region were not identified. The crinoid stems that are abundant in this limestone in other regions appear to be lacking, but brachiopods are abundant. Raymond[9] identified the fauna of the Ames limestone and reports that in almost all the localities where this limestone is seen it is a mass of specimens of *Chonetes granulifer, Ambocoelia Plenoconvexa,* and *Derbya crassa.*

Harlem coal. The Harlem coal was named for the town of Harlem, Carroll County, Ohio, where it has been mined extensively. It was earlier called the Crinoidal coal, from the overlying limestone. In the Smicksburg quadrangle, the Harlem coal lies from immediately under to about 30 feet below the Ames limestone, and from about 285 to 320 feet above the Upper Freeport coal horizon. At most places where the Harlem coal was noted, it is but a few inches thick, or is frequently represented by a streak of carbonaceous shale. The best observed development of this coal occurs in the central east-

[9] Raymond, Percy E., A preliminary list of the fauna of the Allegheny and Conemaugh groups in western Pennsylvania: Topographic and Geologic Survey Commission of Pennsylvania, Report 1908-1910, p. 89, 1911.

Figure 9. Mine on Harlem coal, south of Sportsburg.

ern part of the quadrangle. It had been worked for house coal at three places south of Sportsburg (Fc6, 8, 9); is from 24 to 28 inches thick, but rather poor in quality. From 6 to 10 inches of bony occurs at the top, which material is overlain by dark shale or sandy shale. The coal is underlain by shale or impure clay. A small patch of Harlem coal occurs in a knoll south of Covode (Fd3). The bed was being worked for house coal. Here, also, it is poor in quality, and 30 inches thick with 11 inches of bony on top. The roof is sandy micaceous shale, and the floor is hard shale.

The Harlem coal and its associated beds are shown in the foregoing section obtained north of B.M. 1332. Some of the places where the Harlem was observed elsewhere in the quadrangle are: southwest of Smicksburg (Bd14, 16); southeast of Georgeville (Ee1, 3, 8); and west of Elkin (Ce9).

Bakerstown coals. The Bakerstown coal has some economic value near the place of that name in Richland Township, Allegheny County. In some other areas of western Pennsylvania, two coals have been reported in the interval from below the Harlem coal to the Pine Creek limestone and called the Upper Bakerstown and Lower Bakerstown coal. There appears to be a multiplicity of thin coal beds in the corresponding part of that section in the Smicksburg quadrangle, and correlating any one of them with those in the localities where they were originally described would be doubtful. Therefore, in this report the coals in the interval from below the Harlem coal to the Woods Run limestone are referred to as Upper Bakerstown coals and those from below the Woods Run limestone to the Pine Creek limestone, the Lower Bakerstown coals. At some places where a coal was noted as occurring about the middle of the section between the Harlem coal and the Pine Creek limestone, the Woods Run limestone or its horizon could not be found. In such cases, it was uncertain as to which group of Bakerstown coals the coal in question should be assigned.

The Bakerstown coals are usually only a few inches thick, but locally they have thickened to 24 inches or more and have been dug by the farmers. The Upper Bakerstown coals were seen about Covode, mostly as blooms. The lowermost of this group is 10 inches thick and occurs just above the Woods Run limestone north of Covode (Fc13). Blooms of the Upper Bakerstown coals were also observed northeast of Trade City, and on the upland south of Little Mahoning Creek between North Branch, Plum Creek, and Pine Run. The section obtained in a small quarry on the Woods Run limestone, and the partial section of a diamond drill hole on the Sutter farm presented on the following pages, show the Upper Bakerstown coals and associated beds.

The Lower Bakerstown coals were also observed at numerous places on the uplands south of Mahoning Creek. Northeast of Marion Center on the McMillen farm (Ee28), one of these coals was being worked in a drift. It is 25 inches thick, with 8 inches of bony on top. The roof is sandstone and the floor is clay. On the Hopkins farm, southwest of the above location (Ee33), a higher one of this

group of coals exposed in a gully is 24 inches thick. The coal is overlain by black shale and underlain by clay shale. West of Elkin, a Lower Bakerstown coal had been opened on the Steele farm (De12) and was reported to be from 24 to 30 inches thick and overlain by black shale. The partial section from a diamond drill hole on the Carr farm, and the section measured east of Sportsburg, presented on the following pages, show Lower Bakerstown coals and associated members.

Ewing limestone. A thin shaly carbonaceous limestone containing an abundance of fossils and overlain by dark shale, is exposed in a cut on Route 210, just north of Georgeville (Dd19). This bed has a different lithologic character from that of the Woods Run and also appears to occupy a higher stratigraphic position than that member or about 265 feet above the Upper Freeport coal horizon. It is possible that this bed may correspond to the limestone called the Ewing, which was described from Fayette County.[10]

Woods Run limestone. The Woods Run limestone, which in some reports is called the Cambridge limestone, takes its name from Woods Run near Pittsburgh, where it is well developed, and from which region Raymond[11] has described a variety of marine fossils. They are as follows: *Lophophyllum profundum,* columns of crinoids, *Productus pertenuis, P. nebraskensis, Derbya crassa, Spiriferina kentuckiensis,* and *Diplodus compressus. Lophophyllum* is the most common and often the only fossil found.

The Woods Run limestone in the Smicksburg quadrangle averages about 230 feet above the Upper Freeport coal, is from about 1 to 4 feet thick, and is sparsely fossiliferous. It is invariably deeply weathered at outcrop, and is exposed as nodules in road cuts and quarries. Logs of a few diamond drill holes show this limestone. (See fig. 10, secs. 3, 6, 7.)

Although economically unimportant, this member of the Conemaugh group proved to be a valuable key bed in determining the stratigraphy. The weathered outcrop was found at many places by a residual iron-stained soil, which frequently contains nodules of limonite from the ferruginous shale overlying the limestone. Red shales commonly associated with the horizon are also helpful in locating the limestone.

The Woods Run limestone horizon occurs at numerous places in the uplands south of Little Mahoning Creek and eastward to Pine Run. It is best developed in the vicinity of Covode, and has been quarried in a small way. The best exposure occurs in a small quarry on a knoll, contoured at 1,520 feet, west of the Baltimore & Ohio Railroad, just north of Covode (Fc13). There it is 4 feet of bluish-gray, hard, compact limestone, containing a few scattered fossils. It is reported to have been burned for agricultural lime and to be fairly pure.

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[10] Hickok and Moyer, Geology and Mineral Resources of Fayette County: Pennsylvania Topog. & Geol. Survey Bull. C26, p. 95, 1940.

[11] Raymond, op. cit., p. 89.

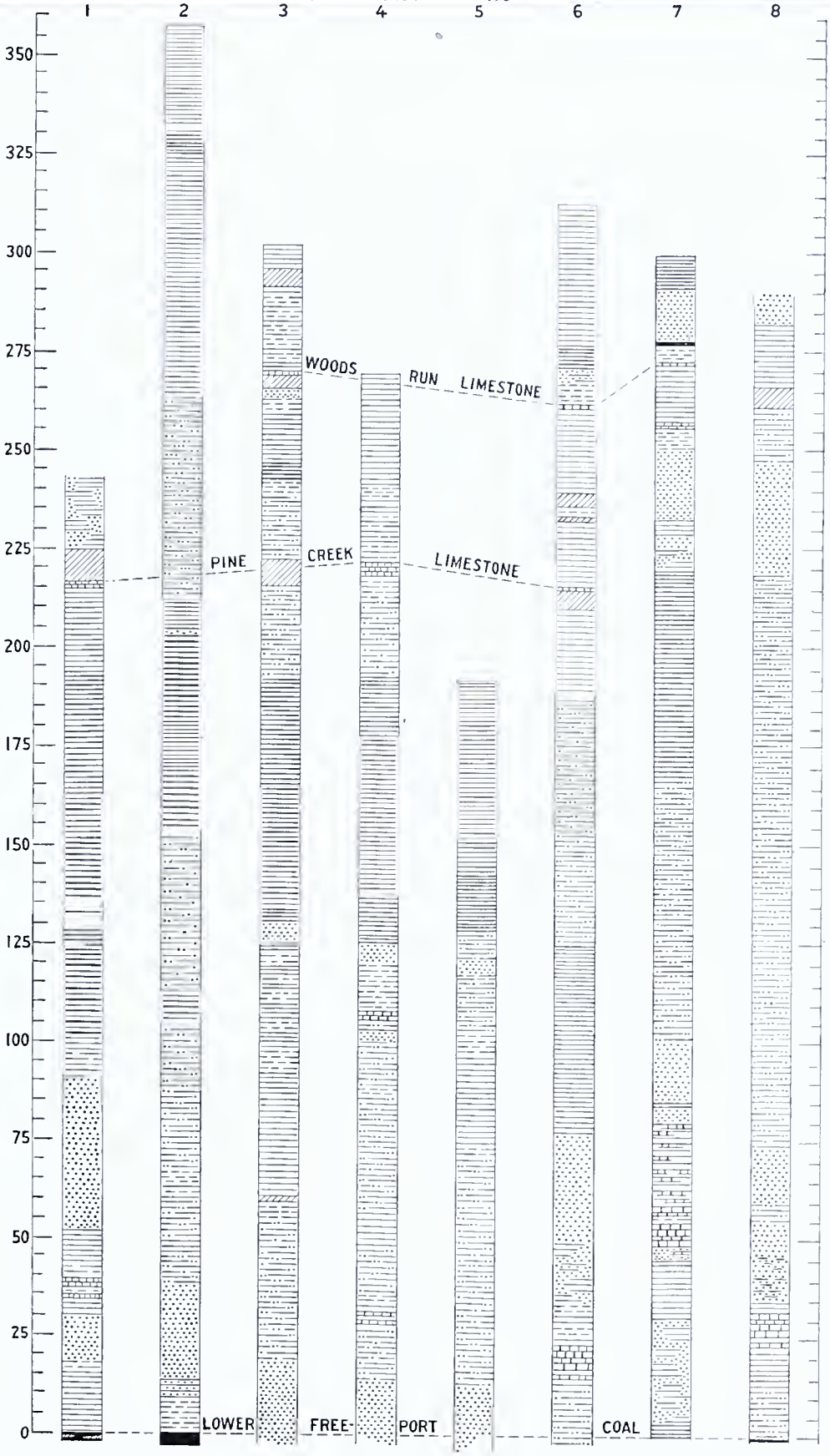


Figure 10. Sections from diamond core drill records showing lower Conemaugh and upper Allegheny groups.

Sections 1-7, Berwind-White Coal Co.; section 8, Clearfield Bituminous Coal Co.

1. Hole on McGregor farm, northeast of Sportsburg, Punxsutawney quadrangle. 2. Hole on Blose farm, northeast of Sportsburg, Punxsutawney quadrangle. 3. Hole on Carr farm, east of Sportsburg, Punxsutawney quadrangle. 4. Hole on Hawk farm, east of Sportsburg, Punxsutawney quadrangle. 5. Hole on Hawk farm, east of Sportsburg, Punxsutawney quadrangle. 6. Hole No. 51, Carr farm, southeast of Fordham. 7. Hole No. 50, Sutter farm, southeast of Fordham. 8. Hole on White farm, southeast of Sportsburg, Punxsutawney quadrangle.

The following section was measured:

Section in limestone quarry north of Covode

	Ft.	in.
Sandstone, gray, shaly, micaceous	3	0
Coal, Upper Bakerstown	0	10
Clay shale with iron nodules	4	0
Limestone, Woods Run	4	0
Clay shale	1+	

One mile west of Covode and just south of B.M. 1484 (Fc17), the limestone had also been quarried and a thickness of 4 feet of good stone was reported. On the Carr farm, three-fourths of a mile southeast of Fordham, a diamond drill hole (fig. 10, sec. 6) penetrated the horizon and the record shows the Woods Run limestone to be 2 feet thick. The following is a partial section of the record:

Diamond drill hole on Carr farm

	Ft.	in
Shale	38	0
Slate, black	4	0
Shale and sandstone	4	0
Clay	5	6
Limestone, Woods Run	2	0
Shale, light	22	0
Shale, red	2	0
Clay	2	6
Clay, red	1	6
Shale, light	16	6
Limestone, Pine Creek	0	9
Shale, red	5	6
Shale, light and sandy	24	0

About one-quarter of a mile south of Fordham, on the Sutter farm, a diamond drill hole penetrated the Woods Run limestone and associated beds (fig. 10, sec. 7). The following is a partial section of the record:

Diamond drill hole on Sutter farm

	Ft.	in.
Shale, dark	9	0
Sandstone, Upper Saltsburg	13	0
Slate, black	0	10
Coal, Upper Bakerstown	0	5
Fire clay	4	0
Limestone, Woods Run	0	9
Shale, light	15	0
Limestone	0	4
Clay	6	0

Saltsburg sandstone. In the Smicksburg quadrangle, the Saltsburg sandstone member of the Conemaugh group occurs in two parts, one or both of which may be present in the same locality; and both may be lacking. The upper part occurs between the Ames and Woods Run limestones. This is the probable equivalent of the Jane Lew sandstone member of the West Virginia Geological Survey. The lower part occurs between the Woods Run and the Pine Creek limestones. It could not be proved, but it is suspected that, at some places, these two parts are continuous, cutting out the Upper Bakerstown

coals and Woods Run limestone. At Saltsburg,[12] in the southwestern corner of Indiana County, which is the type locality of this sandstone, the two parts are not only continuous but cut out the Pine Creek limestone and continue with the Buffalo sandstone, making a thickness of 120 feet.

Both parts of the Saltsburg sandstone have similar characteristics and, therefore, cannot be distinguished lithologically. They range in thickness and occupy nearly all of or various parts of the interval. Where thick and massive, they may grade into shale within a short distance. At the top they are usually thin and cross-bedded, grading downward through medium-grained, heavy beds, to coarse-grained and massive, with lenses of fine conglomerate toward the base. The colors are brown and gray, pinkish, and nearly white. The sandstones are generally composed of subangular quartz grains, and in places are micaceous, particularly where thin-bedded, and are rarely arkosic. Carbonized plant remains were also noted. Irregular lenses and nodules of limonite are common, and they may be cemented by limonite, which makes them more resistant, weathering into boulders up to 8 feet in greatest dimension. They are also loosely cemented and friable.

Both parts of the Saltsburg sandstone are developed locally on the uplands east and west of Smicksburg, and south of Mottarns Mill near Gilgal Church. Only the upper part is prominent northeast and southeast of Hoosicks Mill and west of Denton. The lower sandstone, which is more persistent, is well developed in the vicinity of Covode and Marchand, and about Georgeville, where it is a prominent feature of the uplands and makes the relatively flat topography. The maximum thickness of the upper part could not be definitely determined, but is estimated to be up to 60 feet. The maximum thickness of the lower part is 40 feet.

Pittsburgh and Meyersdale red beds. Where the section from the Ames limestone to below the Pine Creek limestone is mainly composed of shale, it frequently contains red shales. The red shales occurring between the Ames and the Woods Run limestones are called the Pittsburgh[13] red beds because of their prominence in that part of the section of the Conemaugh in the region about Pittsburgh. Those occupying the section between the Woods Run limestone to below the Pine Creek limestone were named by Richardson[14] the Meyersdale red beds, because of their development in that interval at Meyersdale in southern Somerset County.

The red beds in the Smicksburg quadrangle are variable in number, and, although as a general rule they occur within close proximity to the limestones, they do not occupy any definite positions, and likely may occur any place in the section. They, therefore, have an uncertain stratigraphic value. Two color varieties were noted, a brick-red and a purplish-red. The brick-red variety invariably crops

[12] Johnson, M. E., Geology and Mineral Resources of the Greensburg quadrangle, Pennsylvania: Pennsylvania Topog. and Geol. Survey, Atlas 37, 1926.

[13] Johnson, M. E., Geology and Mineral Resources of the Pittsburgh Quadrangle, Pennsylvania: Pennsylvania Topog. and Geol. Survey, Atlas 27, 1928.

[14] Richardson, G. B., U. S. Geol. Survey Geol. Atlas, Somerset-Winber folio (no. 224), 1934.

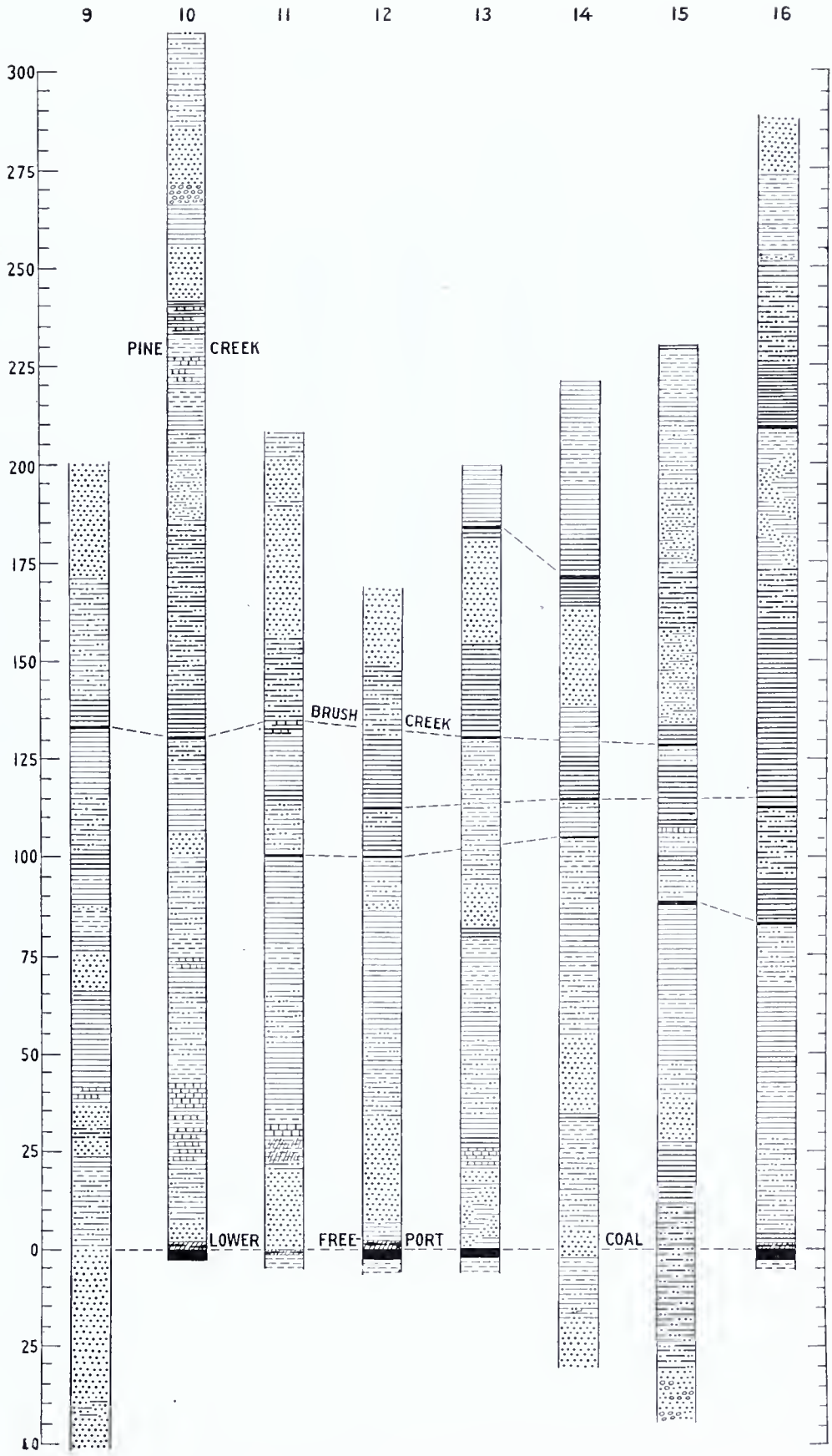


Figure 11. Sections from diamond core drill records of the Clearfield Bituminous Coal Co., showing lower Conemaugh and upper Allegheny groups.

9. Hole on Snyder farm, northeast of Covode, Punxsutawney quadrangle. 10. Hole on Miller farm, northeast of Marchand, Punxsutawney quadrangle. 11. Hole on Neal farm, east of Marchand, Punxsutawney quadrangle. 12. Hole on Emerick farm, east of Marchand, Punxsutawney quadrangle. 13. Hole on Shields farm, east of Marchand, Punxsutawney quadrangle. 14. Hole No. 77 Shields farm, southeast of Marchand. 15. Hole No. 76 Rudolph farm, east of Marchand. 16. Hole on Hoag farm, southeast of Covode, Punxsutawney quadrangle.

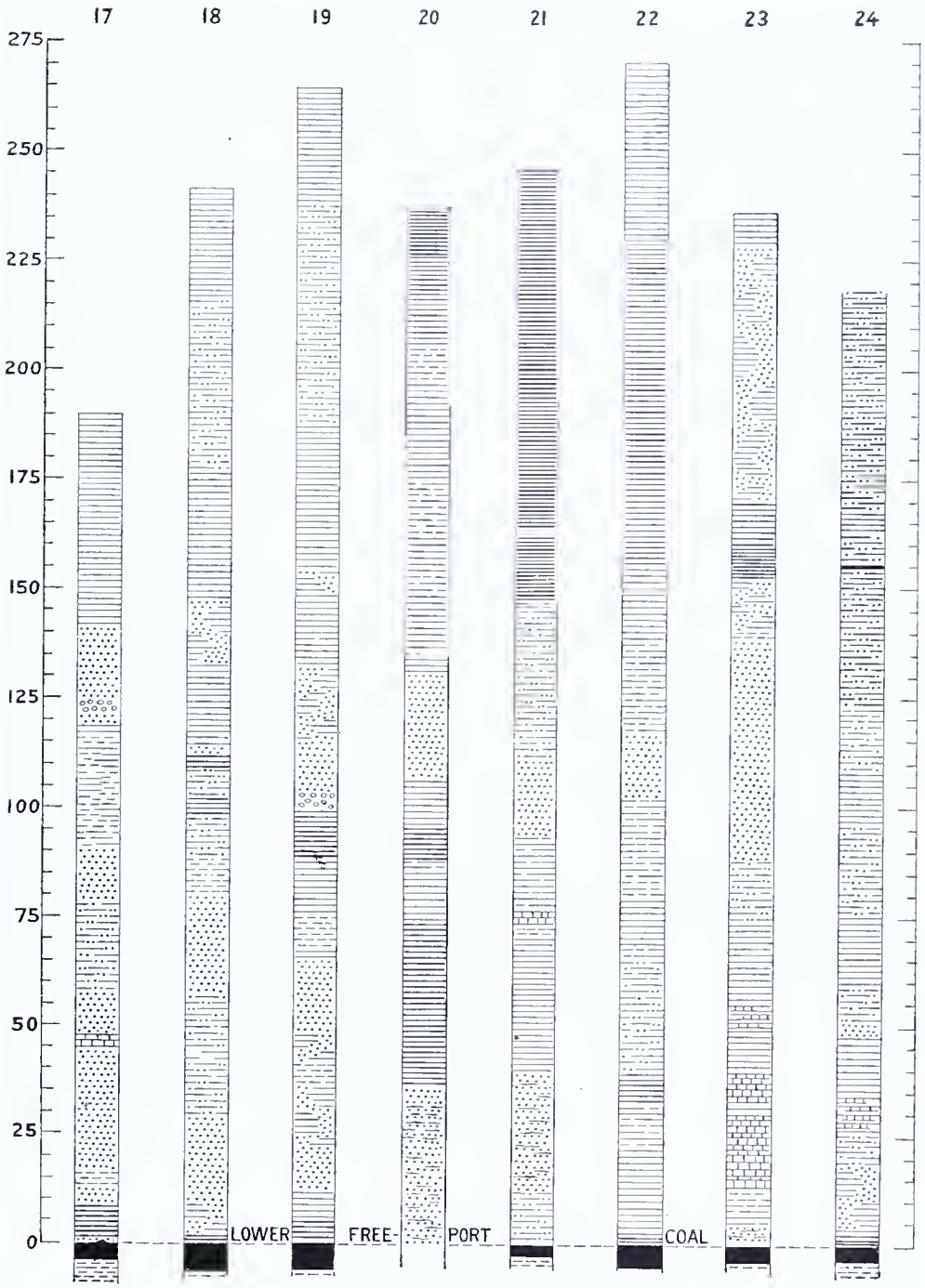


Figure 12. Sections from diamond core drill records showing lower Conemaugh and upper Allegheny groups.

Sections 17-23, Berwind-White Coal Co.; section 24, Pansy Coal Co.

17. Hole No. 35 Williams farm, north of Sportsburg. 18. Hole No. 36 Williams farm, north of Sportsburg. 19. Hole No. 37 Williams farm, north of Sportsburg. 20. Hole on McGregor farm, northeast of Sportsburg, Punxsutawney quadrangle. 21. Hole No. 40 McGregor farm, northeast of Sportsburg. 23. Hole No. 57 Snyder farm, south of Fordham. 24. Hole No. 66 Miller farm, southwest of Valier.

out as a structureless mass of plastic red clay, which quite often has a white plastic clay associated with it. The purplish-reds are frequently exposed in an unweathered condition showing their shaly structure. Fragments of red earthy hematite, some of which show a submetallic luster, are common at the outcrops. No accurate thicknesses of these red beds could be measured on the surface, but the records of some diamond drill holes show a thickness of from 1 to 8 feet (fig. 10, secs. 1, 3, 6, 8).

Red beds are particularly prominent south of Dayton, about Denton, Plumville, Sagamore, Elkin, and north and west of Covode. The following partial section of a diamond drill hole on the Carr farm (fig. 10, sec. 3) south of Fordham shows some of the red beds. See also plate 4, sections 6-17.

Partial record of drill hole on Carr farm

	Ft.	in.
Shale, light	6	0
Red bed	4	8
Shale and fire clay	20	0
Limestone, Woods Run	2	5
Red bed	3	5
Sandstone, gray	3	0
Clay shale	3	0
Shale, light	11	6
Shale, black	6	4
Bony coal, Lower Bakerstown	0	4
Clay	2	6
Shale, light and sandy	17	0
Red bed	6	7

Pine Creek limestone. A marine limestone ranging from 165 to about 185 feet above the Upper Freeport coal is known as the Pine Creek. It is too thin and impure to be worked by the farmers for agricultural lime; and being too deeply weathered to crop out, only a few exposures were found in road cuts. The thickness ranges from a few inches up to an observed thickness of 2 feet, 8 inches. The fresh surface is bluish-gray. The weathered surface is yellowish or greenish-gray. Olive and buff shale with interbedded red beds are generally associated with the lime, and a thin bed of nodular limonite frequently occurs in the shale directly above the lime, marking the weathered outcrop, and for that reason this limestone was a useful "key" bed.

The best exposure of the Pine Creek limestone found occurs on the north fork of the road eastward from Sportsburg, just over the boundary in the Punxsutawney quadrangle. The following is the section:

Section east of Sportsburg

	Ft.	in.
Red bed	1+	0
Carbonaceous shale, Lower Bakerstown coal horizon	0	3
Clay	1	0
Limestone, Pine Creek	2	8
Shale, olive	7+	0

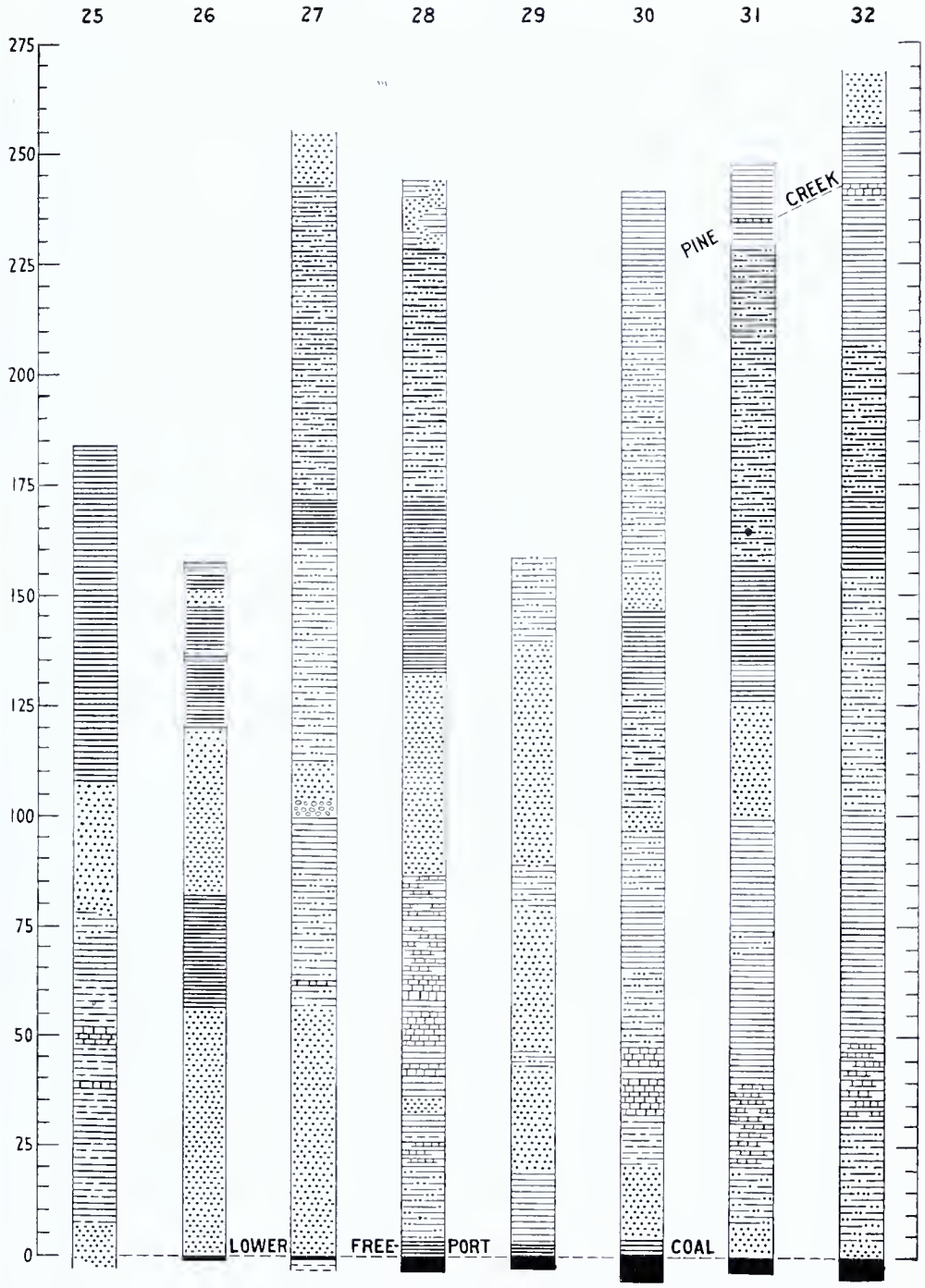


Figure 13. Sections from diamond core drill records of the Berwind-White Coal Co., showing lower Conemaugh and upper Allegheny groups.

25. Hole on Blose farm, northeast of Sportsburg, Punxsutawney quadrangle. 26. Hole No. 47 Pinter farm, south of Sportsburg. 27. Hole No. 49 Carr farm, east of Fordham. 28. Hole No. 54 Sutter farm, southeast of Fordham. 29. Hole No. 55 Walker farm, southeast of Fordham. 30. Hole No. 58 Sutter farm, southeast of Valier. 31. Hole No. 63 Wilhelm farm, south of Valier. 32. Hole No. 64 Wilhelm farm, south of Valier.

The following are partial sections from records of diamond drill holes that show the Pine Creek limestone and associated beds:

Section from drill hole on McGregor farm northeast Sportsburg (fig. 10, sec. 1)

	Ft.	in.
Sandstone and shale	18	3
Red bed	8	6
Limestone, Pine Creek	1	7
Shale		

Section from drill hole on Wilhelm farm south of Valier (fig. 13, sec. 31)

	Ft.	in.
Shale	18	9
Limestone, Pine Creek	0	6
Shale		
Sandstone, Lower Saltsburg	12	0
Shale	14	6
Limestone, Pine Creek	1	4
Clay	1	0
Shale, light	23	6

Numerous nodular exposures of the Pine Creek limestone were found at various places in the quadrangle. Fossils were noted in it at only one place, about one mile west of Ringgold on the road north from B.M. 1427 near the top of the hill (Ba4). Raymond[15] has identified 19 fossil species from the Pine Creek limestone in the vicinity of Pittsburgh, and the fauna is similar to the Brush Creek and the Ames, but lacks the abundance of *Worthenia tabulata* and *Astartella vera* of the one and the *Chonetes granulifer* and *Tainoceras occidentale* of the other.

Buffalo sandstone. The interval between the Pine Creek and the Brush Creek limestones in this area is generally occupied by olive, buff, gray, and dark shales which locally become sandy. At a few places a fairly well-developed sandstone occurs in the upper part of this interval, which in some parts of western Pennsylvania is a prominent feature, and has been called the Buffalo sandstone by I. C. White[16] from its occurrence along Buffalo Creek in Butler County.

An excellent exposure of this sandstone may be seen about half a mile south of Valier along Route 210, just where it turns eastward. There it is flaggy and cross-bedded, brown to gray, medium-grained, and about 25 feet thick. About 1 mile west of Trade City Station, and up the road toward B.M. 1512, the Buffalo sandstone appears in two parts, separated by a few feet of shale. The upper part is about 10 feet thick, is heavy-bedded, coarse-grained, and finely conglomeratic toward the base. The lower part is composed of shaly and thin-bedded sandstone, and is about 20 feet thick. At B.M. 1259, north of Oak Tree, on the road toward Gilgal Church, it is present as a thin-bedded, fine-grained, greenish to brownish sandstone, with interbedded shale, and about 25 feet thick.

[15] Raymond, op. cit., p. 88.

[16] White, I. C., Second Penna. Geol. Survey Report Q, p. 33. 1878.

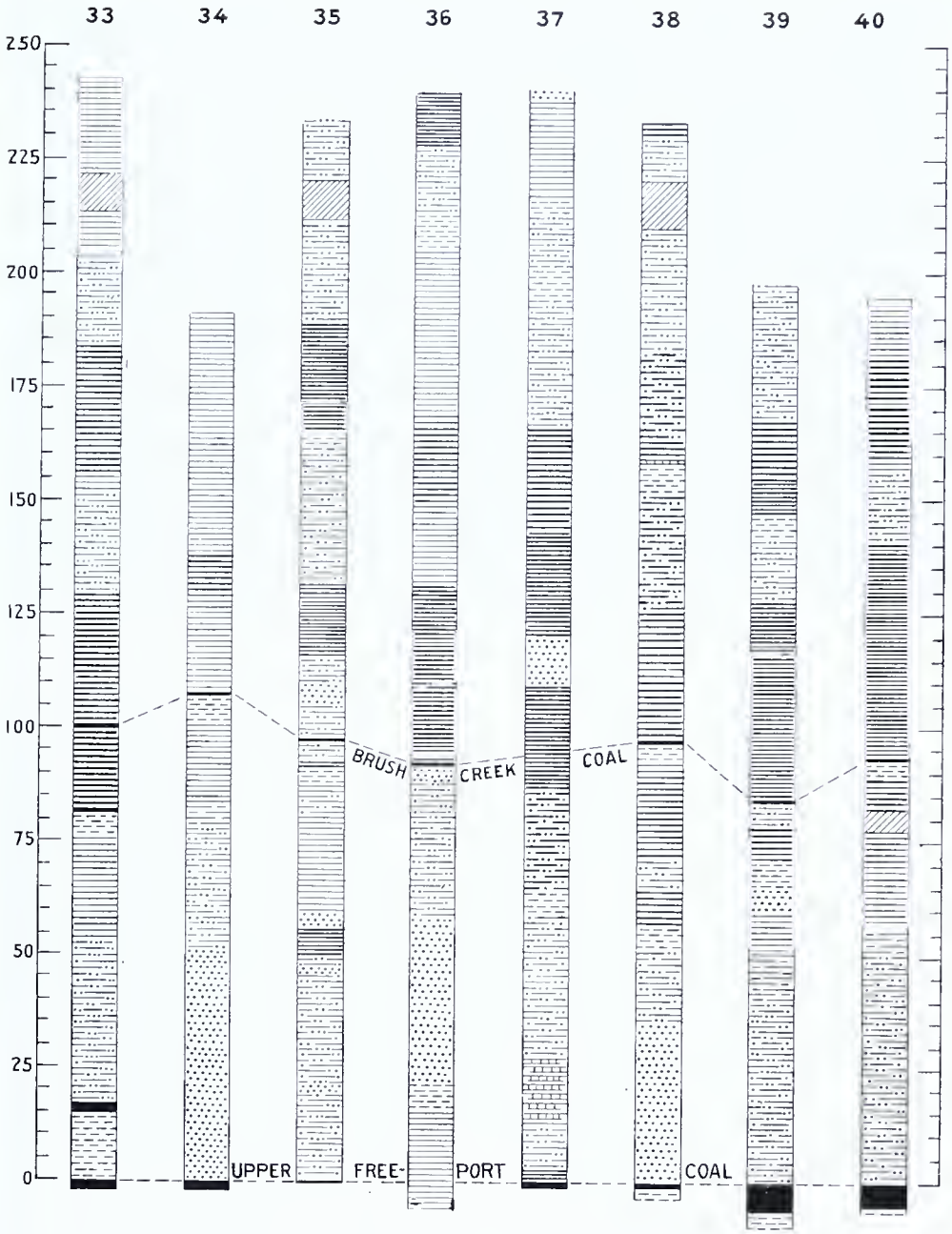


Figure 14. Sections from diamond core drill records showing lower Conemaugh group.

Sections 33, 35, Buffalo, Rochester and Pittsburgh Coal Co.; sections 34, 36-40, Buffalo and Susquehanna Coal and Coke Co.

33. Hole No. 83, Marshall farm, northeast of Barnards. 34. Hole No. 82 Neigh farm, northeast of Barnards. 35. Hole No. 81 Barnard farm, northeast of Barnards. 36. Hole No. 85 Rowland farm, northwest of Denton. 37. Hole No. 86 Marshall farm, southeast of Denton. 38. Hole No. 92 Lowry farm, south of Denton. 39. Hole No. 98 Neff farm, northeast of Hoosicks Mill. 40. Hole No. 97 Miller farm, north of Hoosicks Mill.

Figure 15. Buffalo sandstone, south of Valier.

Brush Creek limestone and coals. This limestone and the accompanying coals were named by I. C. White[17] for their occurrence along Brush Creek in Butler County. Although locally replaced by other materials, the Brush Creek limestone and coals are the most persistent and easily recognized horizon in the lower part of the Conemaugh group in this area, and were traced throughout much of the southern half of the quadrangle. They consist of a grayish black, fossiliferous limestone, and at least two thin coals. Associated with the horizon is a variable thickness of gray to black shale, which may, in part, be fissile and of a variety known as chip shales. A striking feature of this horizon is the wide range in interval from the Upper Freeport coal, which ranges from 60 to about 110 feet. This appears to be not unusual, since the Brush Creek and the Upper Freeport in the Foxburg-Clarion quadrangles[18] is reported to be from 75 to 100 feet, and Johnson[19] gives this interval in the Pittsburgh quadrangle as from 69 to 110 feet. The following table gives the intervals from the Brush Creek to the Upper Freeport in various parts of the Smicksburg quadrangle:

Intervals from Brush Creek coal to Upper Freeport coal

	Feet		*Feet*
Dayton	110	South of Trade City	60
Smicksburg	75	McCormick	60
South of Valier	110	Denton	90
South of Sportsburg	100	Barnards	90-100
Marchand	90	Hoosicks Mill	110
Mottarns Mill	60	North of Sagamore	135
Trade City	80	West and south of Sagamore	100
		Plumville	90

[17] White, I. C., op. cit., pp. 34-35, 1878.
[18] Shaw, Lines and Munn, U. S. Geol. Survey Geol. Atlas, Foxburg-Clarion folio (no. 178), 1911.
[19] Johnson, M. E., op. cit., p 71.

The Brush Creek limestone in this area is generally comparable to the descriptions given it in other regions of western Pennsylvania. It is grayish-black, hard, dense, breaks with a subconcoidal fracture, and is exposed as boulders which average about 1 foot thick. Fossils are present, particularly in the shaly upper part, where they are usually abundant. This limestone is impure and easily weathered, but where it is entirely disintengrated the fossils are still fairly well preserved, and it is mostly by this means that the horizon was located.

Raymond[20] has listed a variety of fauna from the Brush Creek limestone.

An unusual occurrence of the Brush Creek limestone, which probably is only a local development, was discovered in a cut along the Baltimore & Ohio Railroad at Barton, about 1½ miles north of Marion Center (Ee39). Here the calcareous fossiliferous shaly phase is separated from the main body of the limestone by 4 feet of sandy clay, and the limestone lacks its dark carbonaceous character, but is greenish-gray and 30 inches thick. The following section was obtained:

Section in Baltimore & Ohio Railroad cut north of Marion Center

	Ft.	in.
Shale, dark, sandy and micaceous, with siderite concretions..	10+	0
Shale, dark, sandy, calcareous, fossiliferous.....	0	6
Clay, hard, sandy, greenish-gray, weathers reddish-brown....	4	0
Limestone, Brush Creek, greenish-gray, hard, compact.....	2	6
Clay	1+	0

Two, and occassionally three, thin coals accompany the Brush Creek limestone. Mine operators and diamond core drillers in this region call the coal lying about 100 feet above the Upper Freeport, the Gallitzin coal, which is a minable coal about that place in central Pennsylvania.

Two of these coals occur immediately above and below the limestone, and one from 10 to 20 feet below. The greatest thickness observed of any of these coals is 10 inches; but on the hill south of and overlooking Smicksburg (Bd7), one of the upper coals had been prospected and was reported to be 20 inches thick. About three-fourths of a mile southwest of Trade City (Dd1) one of the Brush Creek coals also had been opened and reported as 20 inches thick.

Good exposures of the Brush Creek horizon were found at the following places: A short distance up the road ascending the hill west of Smicksburg (Bd10); at the west portal of the tunnel on the Baltimore & Ohio Railroad east of Fordham (Fe4); south of Marchand just below Covenanter Church on Route 119 (Fe1); north of Oak Tree at B.M. 1259 (Ee19); west of Barnards on the road up Spruce Run (Ae2, 3), and along Route 210 north of Plumville, just south of Allison School (Ce12). The following sections were measured:

Section at west portal of B. & O. tunnel east of Fordham

	Ft.	in.
Shale, dark	15+	0
Shale, dark, limy, sandy, fossiliferous, Brush Creek.....	0	5
Shale, dark	15	0
Coal, Brush Creek.....	0	7
Shale, dark	20+	0

[20] Raymond, op. cit., p. 85.

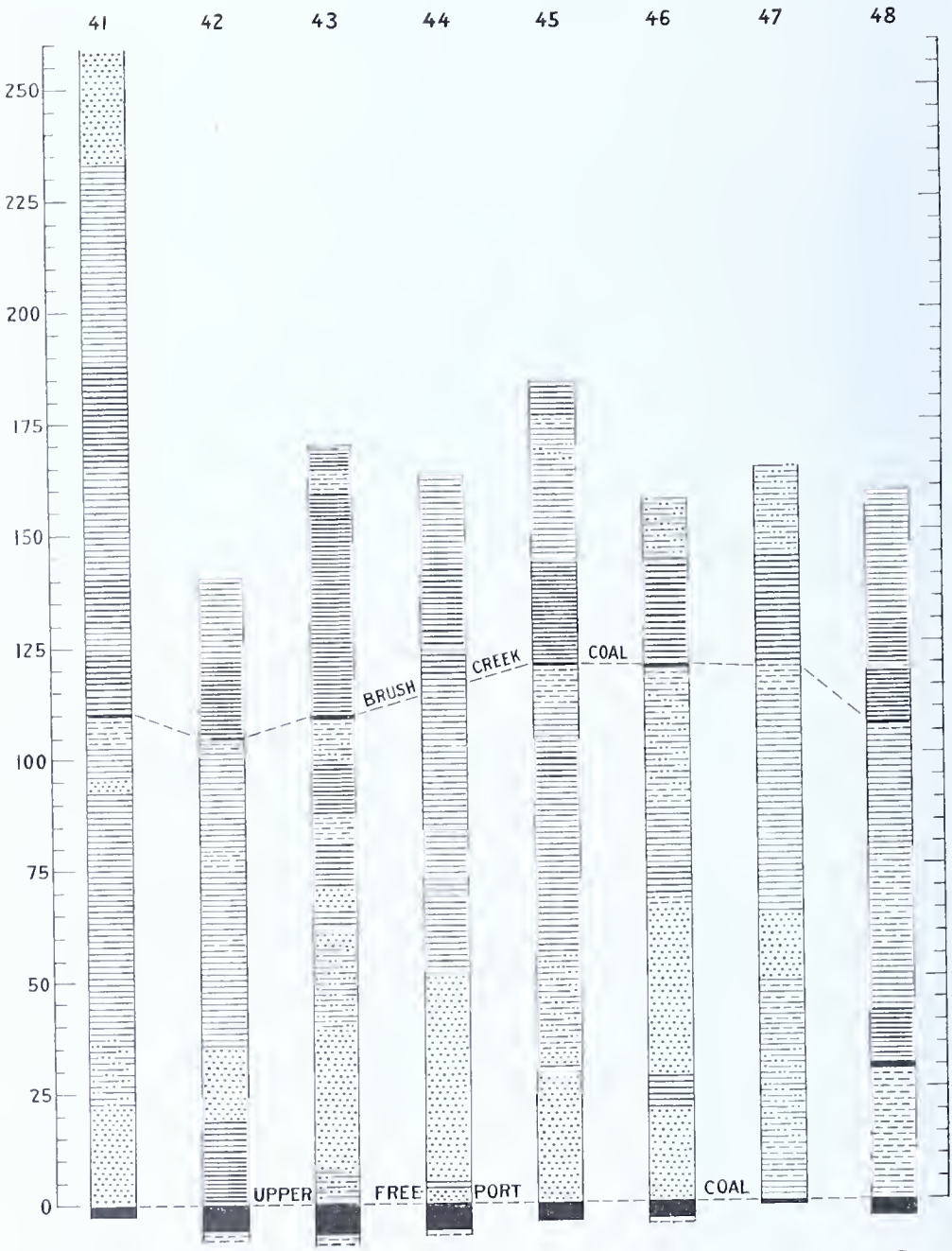


Figure 16. Sections from diamond core drill records showing lower Conemaugh group.

Sections 41-45, 47, 48, Buffalo and Susquehanna Coal and Coke Co.; section 46, Sutter-Rinn Coal Co.

41. Hole No. 126, south of Sagamore. 42. Hole No. 123 Peffer farm, southwest of Sagamore. 43. Hole No. 119 Elkin farm, west of Sagamore. 44. Hole No. 125 Allshouse farm, southeast of Sagamore. 45. Hole No. 99 Rairie farm, northeast of Hoosicks Mill. 46. Hole on Stuchell farm, north of Plumville. 47. Hole No. 105, east of Plumville. 48. Hole No. 103 Davis farm, east of Plumville.

Figure 17. Brush Creek limestone and shale, at Smicksburg.

Section south of Marchand on Route 119

	Ft.	in.
Shale, black, sandy, weathers rust-brown	15+	0
Clay shale, dark	0	2
Coal, Brush Creek	0	2
Clay	0	3
Shale, dark, limy, fossiliferous, Brush Creek	0	3
Limestone, grayish-black, Brush Creek	0	4
Shale, dark, chip shale in part	20	0
Coal, Brush Creek	0	4
Clay, greenish, sandy	5+	0

Section north of Oak Tree at B.M. 1259

	Ft.	in.
Shale, dark gray to black	28	0
Coal	0	3
Shale, dark, limy and fossiliferous, Brush Creek	0	4
Limestone, grayish-black and fossiliferous, Brush Creek	0	11
Shale, black	20	0
Fire clay		

Section on Route 210 north of Plumville

	Ft.	in.
Shale, greenish-gray		
Shale, black, fissile and chip shale	18	0
Shale, dark, limy, fossiliferous, Brush Creek	1	3
Limestone, grayish-black, fossiliferous, Brush Creek	0	3
Coal	0	4
Clay, gray and sandy	4+	0

See also accompanying figures.

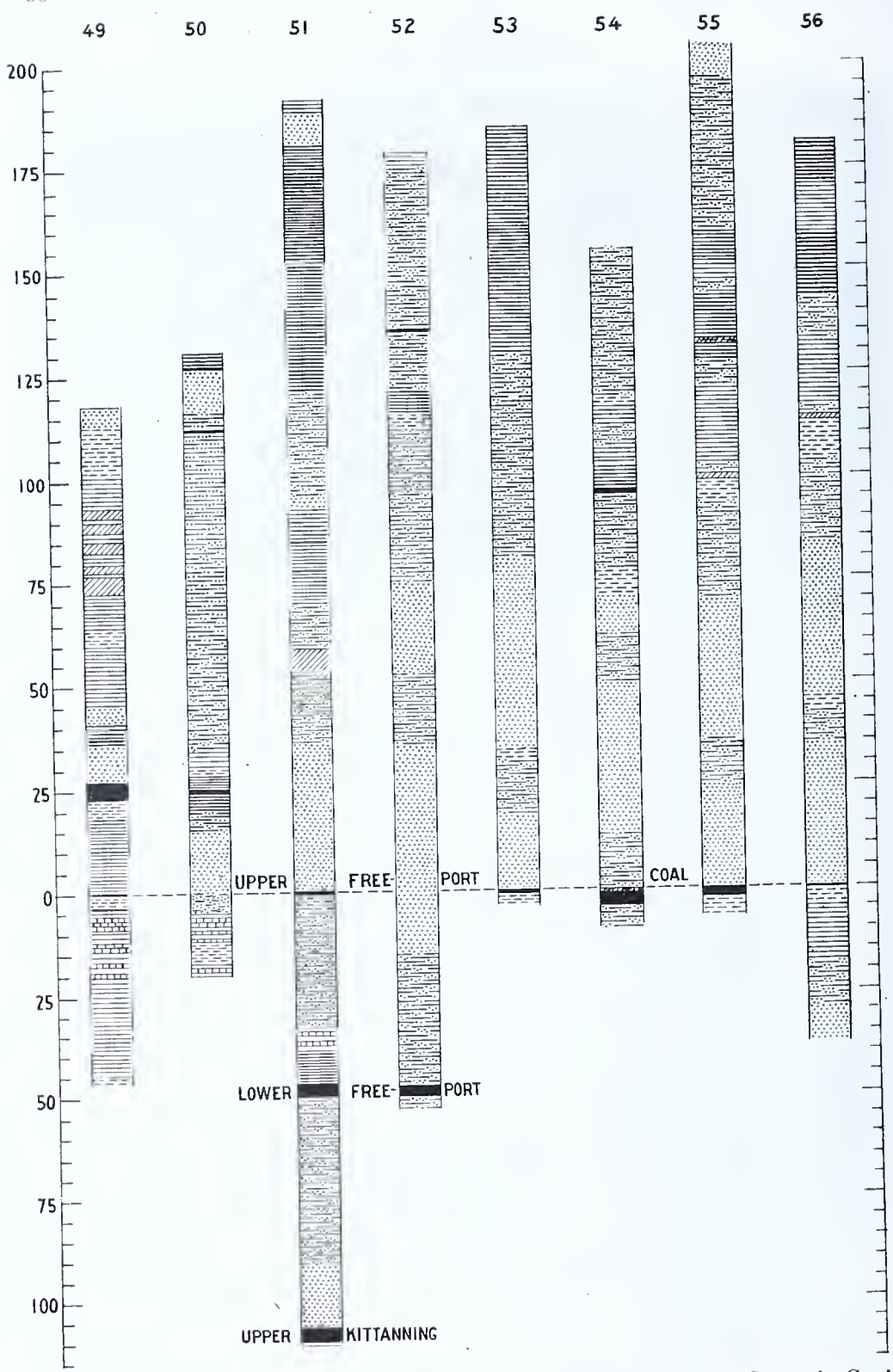


Figure 18. Sections from diamond core drill records of the Summit Coal Co. showing lower Conemaugh and upper Allegheny groups.

49. Hole on McIntire farm, south of Dayton. 50. Hole on Coleman farm, south of Dayton. 51. Hole on Marshall farm, south of Dayton. 52. Hole on Marshall farm, south of Dayton. 53. Hole on McElwee farm, southeast of Dayton. 54. Hole on McElwee farm, southeast of Dayton. 55. Hole on McElwee farm, southeast of Dayton. 56. Hole on Blose farm, southeast of Dayton.

Brush Creek upper limestone. Subsequent to the deposition of material that formed what is in this area taken to be the true Brush Creek limestone, there appears to have been, at least locally, a repetition of similar sedimentation resulting in limestone with characteristics similar to the Brush Creek.

Just north of Sagamore (Af2), the Brush Creek limestone is present, 100 feet above the Upper Freeport horizon, and with one of its accompanying coals, 2 feet below the limestone. Another limestone (Af3) lithologically similar to typical Brush Creek occurs 38 feet above, and separated by dark shale. West of Sagamore (Bf5), a dark fossiliferous limestone, also like the Brush Creek, is 150 feet above the Upper Freeport coal horizon; and a grayish-black fossiliferous limestone, with a lithology like the Brush Creek, crops out south of Dayton (Ad2) and is 145 feet above the Upper Freeport horizon.

Mahoning sandstone. With the exception of being more micaceous, the Mahoning sandstone is similar to the overlying sandstones in the Conemaugh group. It possesses the same color variations, is medium- to coarse-grained, grades from thin to heavy beds, and is locally massive and finely conglomeratic. The limits of the Mahoning sandstone are generally considered to extend from the Brush Creek coals and limestone to the Upper Freeport coal. In this region, the sandstones occupying that interval frequently cut out part or all of the Upper Freeport coal, and at some places appear to have replaced the Brush Creek horizon. The records of some diamond drill holes show up to 105 feet of what appears to be a continuous bed of sandstone. Usually, however, it is separated into two or more parts of variable thickness, and is thicker and more persistent in the lower part of the interval. See accompanying figures.

The Mahoning sandstone is poorly developed or absent at some places, particularly where the interval from the Brush Creek to the Upper Freeport coal is small, but throughout most of the quadrangle, more or less sandstone occurs where this rock interval is exposed, and is present in most of the drill holes that have pierced it. This sandstone does not seem to be a cliff maker, but where massive it breaks into large boulders which cover the surface and choke the ravines. It is the cap rock and makes the relatively flat hilltops south of Timblin and Dora and in the vicinity of Grange. Its massive character is displayed at numerous places in the quadrangle, among which are the following: North of Grange along Route 536, north of Hamilton, at B.M. 1528 north of Valier, and along Mahoning Creek at the eastern boundary.

Mahoning coal and limestone. The Mahoning coal and limestone are prominent members of the Lower Conemaugh group in some regions of western Pennsylvania, and occur about midway between the Brush Creek and the Upper Freeport coals. In the Smicksburg quad-

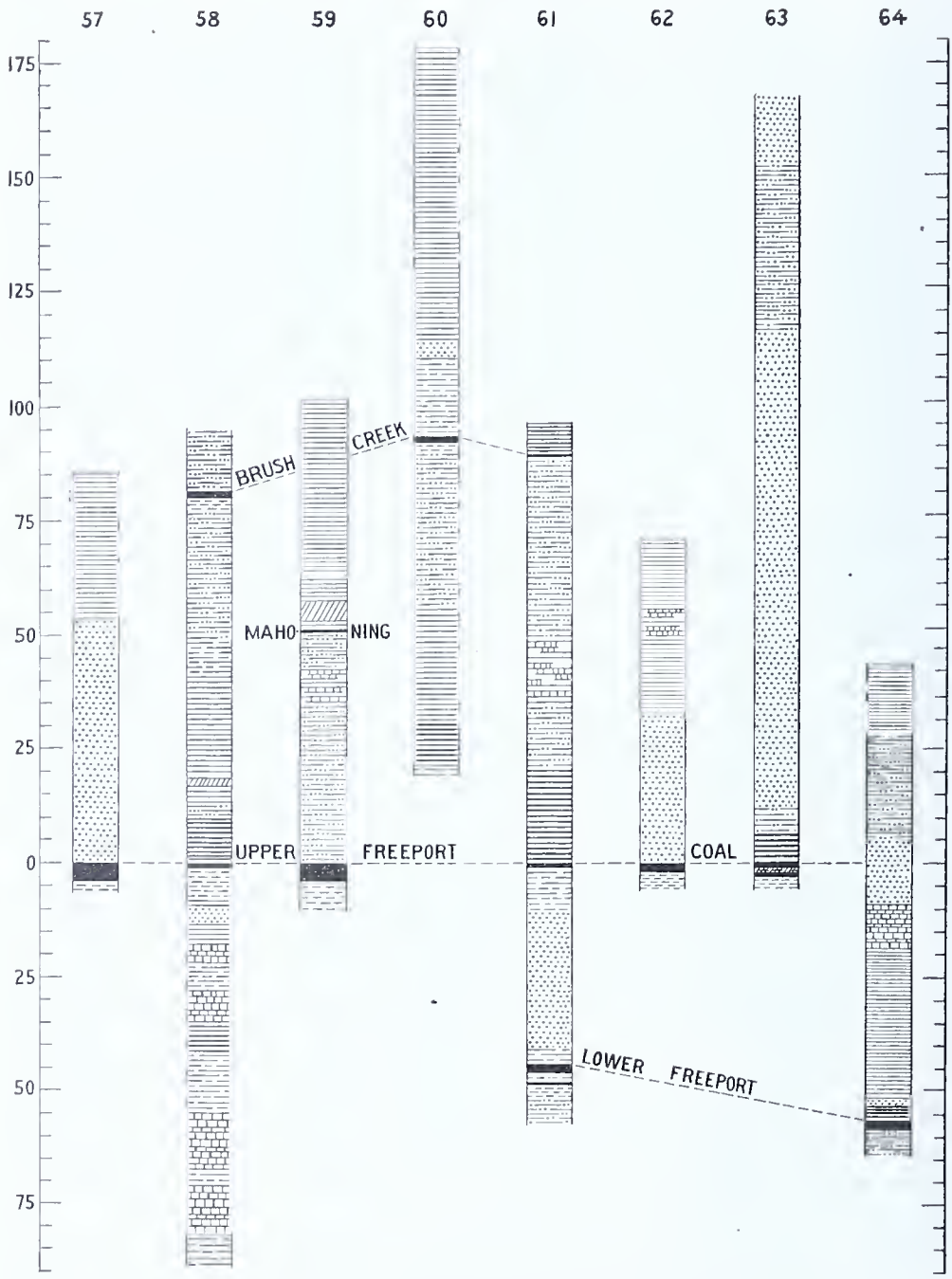


Figure 19. Sections from diamond core drill records showing lower Conemaugh and upper Allegheny groups.

Section 57. Sutter-Rinn Coal Co.; sections 58-64, Buffalo & Susquehanna Coal and Coke Co.

57. Hole on Sutter farm, north of Plumville. 58. Hole No. 104, Weaver farm, east of Plumville. 59. Hole No. 102, Heberling farm, northeast of Plumville. 60. Hole No. 101, Neff farm, southwest of Rossmoyne. 61. Hole No. 90, Davis farm, southwest of Rossmoyne. 62. Hole No. 88, Mogle farm, west of Rossmoyne. 63. Hole No. 87, Good farm, west of Rossmoyne. 64. Hole No. 72, southwest of Trade City.

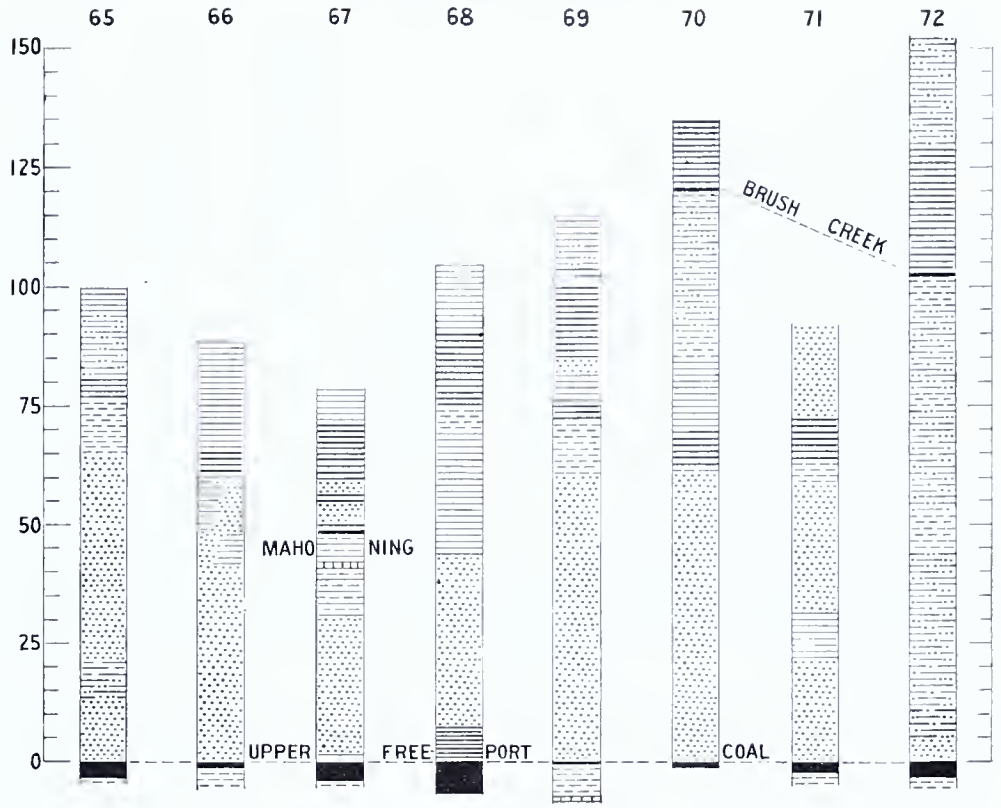


Figure 20. Sections from diamond core drill records showing lower Conemaugh group.

Sections 65-69, Buffalo & Susquehanna Coal and Coke Co.; sections 70-72, Sutter-Rinn Coal Co.

65. Hole No. 122, Streams farm, southeast of Sagamore. 66. Hole No. 114, Stewart farm, south of Plumville. 67. Hole No. 106, Beltz farm, east of Plumville. 68. Hole No. 109, Marshall farm, northwest of Plumville. 69. Hole No. 107, Tucker farm, north of Plumville. 70. Hole on Tucker farm, north of Plumville. 71. Hole on Cribbs farm, north of Plumville. 72. Hole on Thompson farm, north of Plumville.

rangle these beds are generally absent, being replaced by sandstone or sandy shale, or where present are not well developed, being marked by a carbonaceous shale, a thin coal, clay, or a streak of red clay with yellow flint-like clay and occasional nodules of iron ore. A coal apparently only a few inches thick and about 40 feet above the Upper Freeport, was noted just north of Dayton (Ac41). In the ravine west of Smicksburg (Bd9), a coal 10 inches thick also occurs about 40 feet above the Upper Freeport. Southwest of Sagamore, in a cut along the railroad at a point opposite B.M. 1075 (Af9), 12 inches of bluish-gray limestone is exposed, and is about 45 feet above the Upper Freeport coal. The yellow flint-like clay which marks the position of the Mahoning limestone occurs at a few places near Marion Center (Ff16, 26).

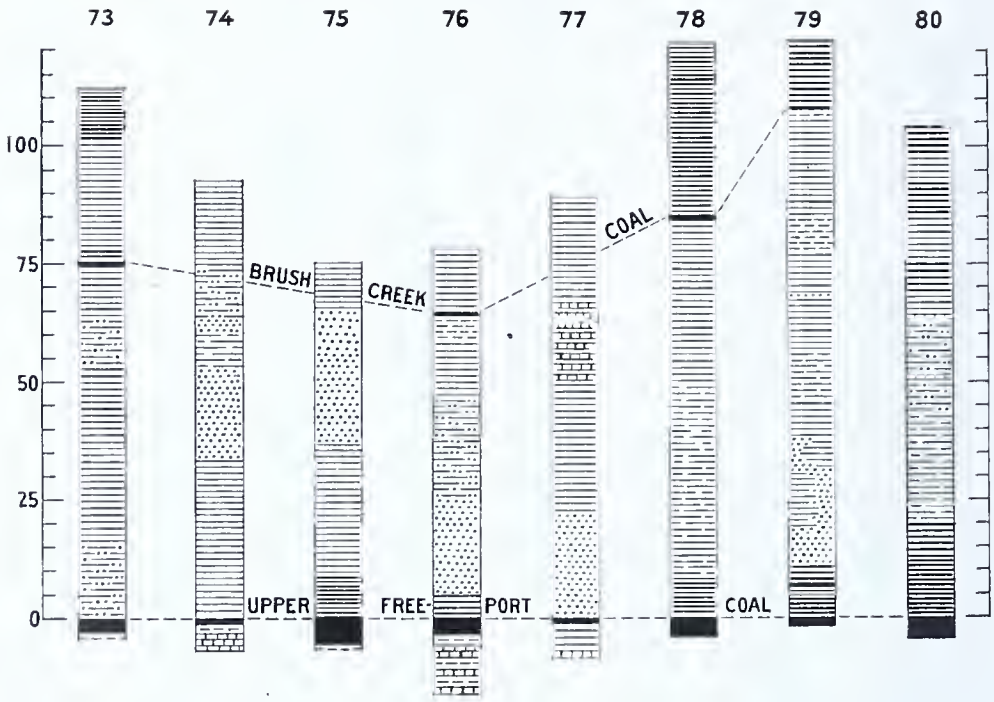


Figure 21. Sections from diamond core drill records of the Buffalo & Susquehanna Coal and Coke Co. showing lower Allegheny group.

73. Hole No. 80, Burns farm, northwest of Barnards. 74. Hole No 95, Miller farm, west of Barnards. 75. Hole No. 96, Moore farm, southwest of Barnards. 76. Hole No. 94, Calvert farm, north of Barnards. 77. Hole No. 95a, Doutts farm, at Barnards. 78. Hole No 93, Barnard farm, southeast of Barnards. 79. Hole No. 111, Mairie farm, at Hoosicks Mill. 80. Hole No. 110, east of Hoosicks Mill.

Sections of the Mahoning coal and limestone with associated beds were not obtainable on the surface, but the following partial and complete records of diamond drill holes show them:

Heberling farm northeast of Plumville (fig. 19, sec. 59)

	Ft.	*in.*
Shale	2	6
Bony coal, Mahoning	0	7
Shale, sandy	7	5
Shale, with interbedded limestone, Mahoning	8	0
Shale, sandy	7	10
Shale, light and sandy	25	6
Coal, Upper Freeport	3	0

Mogle farm west of Rossmoyne (fig. 19, sec. 62)

	Ft.	*in.*
Shale	14+	0
Shale and limestone, Mahoning	6	0
Shale, light	18	0
Sandstone, Lower Mahoning	33	2
Coal, Upper Freeport	1	6

Beltz farm east of Plumville (fig. 20, sec. 67)

	Ft.	in.
Shale, dark	13+	0
Sandstone	2	8
Shale, dark	1	4
Sandstone	5	5
Shale, dark	1	0
Coal, Mahoning	0	3
Clay and shale	6	3
Limestone and shale	1	2
Shale and clay	10	6
Shale and sandstone	25	1
Sandstone	3	6
Shale, light	1	10
Coal and bone, Upper Freeport	1	3
Coal	4	3

East of Hoosicks Mill

	Ft.	in.
Shale	40+	0
Limestone, Mahoning	1	0
Shale, sandy	12	0
Limestone, Mahoning	1	0
Shale, sandy	4	0
Clay shale	26	0
Shale, dark	7	0
Shale, black	9	0
Coal, Upper Freeport		

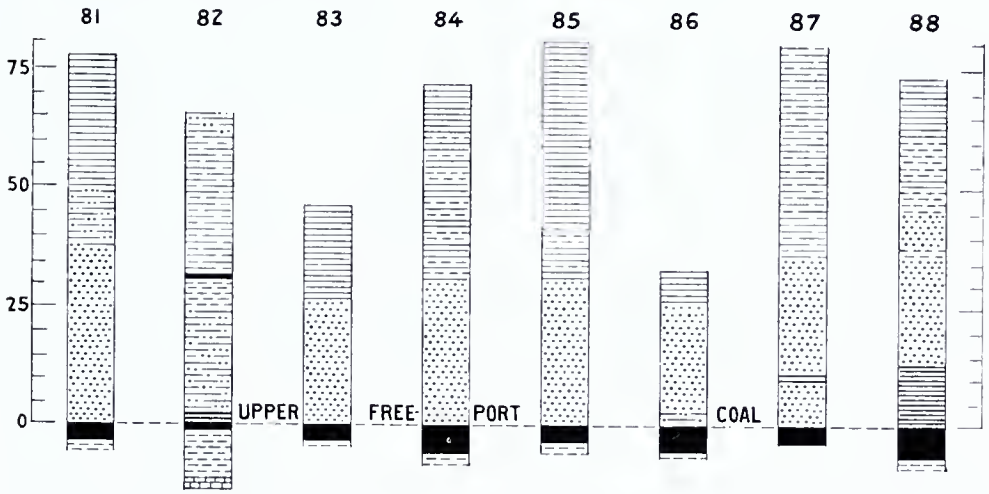


Figure 22. Sections from diamond core drill records of the Buffalo & Susquehanna Coal and Coke Co. showing lower Conemaugh group.

81. Hole No. 124, Weamer farm, southeast of Sagamore. 82. Hole No. 121, McCausland farm, south of Sagamore. 83. Hole No. 120, Johnston farm, east of Sagamore. 84. Hole No. 118, northeast of Sagamore. 85. Hole No. 117, northeast of Sagamore. 86. Hole No. 116, northwest of Sagamore 87. Hole No. 113, northeast of Sagamore. 88. Hole No. 112, north of Sagamore.

McCausland farm south of Sagamore (fig. 22, sec. 82)

	Ft.	in.
Shale, light, sandy	4	0
Clay shale	30	0
Coal, Mahoning	1	0
Clay	6	2
Shale, light, sandy	23	0
Shale, black	1	0
Coal, Upper Freeport	1	7

Uffington shale. At some places on the surface in this area, and as may be seen in some of the above sections of diamond drill holes, the interval from the Mahoning coal and limestone horizon to the Upper Freeport coal is predominantly or entirely composed of shale. I. C. White[21] called this the Uffington shale from its exposure at that place south of Morgantown, West Virginia, and reports it as containing not only an abundant flora, but also a marine fauna. No marine fossils were observed in this shale in the Smicksburg quadrangle, but plant impressions were noted in the shale overlying the Upper Freeport coal.

Piedmont or Upper Freeport rider coal. In the southwestern part of the quadrangle, the records of two diamond drill holes show a coal of local occurrence 3 feet and 14 inches thick, lying 14 and 27 feet, respectively, above the Upper Freeport coal and separated from it mostly by clay. The position of this bed corresponds to the coal that in other regions has been designated as the Piedmont or Upper Freeport rider coal. The following partial sections of diamond drill holes show this coal:

Northeast of Barnards (fig. 14, sec. 33)

	Ft.	in.
Shale, sandy	30	0
Bony coal	0	9
Coal, Upper Freeport rider or Piedmont	3	0
Clay	13	9
Coal, Upper Freeport	2	0
Clay	7	6
Shale, dark	7	0
Limestone, Upper Freeport	6	6

East of Plumville (fig. 16, sec. 48)

	Ft.	in.
Shale, black	13	0
Coal, Piedmont or Upper Freeport rider	1	2
Clay	17	0
Sandstone	2	6
Clay shale	7	6
Bony coal, Upper Freeport	0	6
Coal, Upper Freeport	3	5
Clay	8	11
Limestone, Upper Freeport		

[21] White, I. C., The Appalachian Coal Field: West Va. Geol. Survey, vol. II, part II pp. 323-325, 1903.

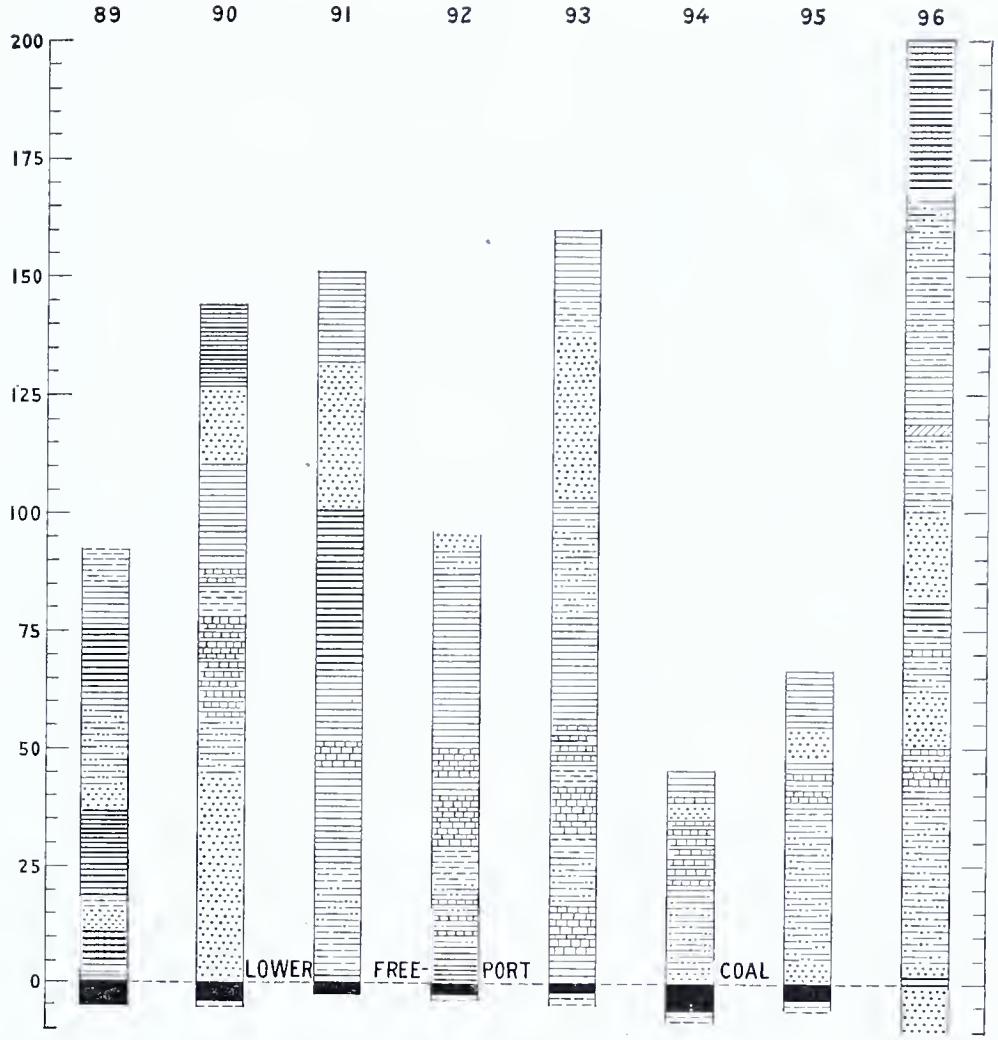


Figure 23. Sections from diamond core drill records showing lower Conemaugh and upper Allegheny groups.

Sections 89-94, Berwind-White Coal Co.; sections 95, 96, Buffalo & Susquehanna Coal and Coke Co.

89. Hole No. 42, Coon farm at Sportsburg. 90. Hole No. 48, Carr farm, east of Fordham. 91. Hole No. 56, Walker farm, south of Fordham. 92. Hole No. 60, Snyder farm, south of Valier. 93. Hole No. 62, Croasman farm, south of Valier. 94. Hole No. 59, Wilhelm farm, south of Valier. 95. Hole No. 65, southwest of Valier 96. Hole No. 67, southwest of Valier.

Intraformational limestones. Two limestones were discovered in the Lower Conemaugh group during the course of this survey, which, because of their character and their positions in the stratigraphic section, could not reasonably be correlated with any of the known limestones, and must be regarded as intraformational limestones.

About one mile northwest of Sagamore at B.M. 1369 (Af1), there is an exposure of a nodular limestone conglomerate, interbedded in shale, which is composed of subangular, waterworn fragments of greenish-gray and light gray limestone, cemented in a ground mass

of bluish-gray limestone. When fractured it breaks across the fragments, forming a mosaic pattern. Only loose fragments were seen, so the thickness is not known.

Southeast of Sagamore, at the top of the hill on the road west from B.M. 1152 (Af14), a limestone conglomerate is exposed, similar to the above, interbedded in buff shale with red beds. These limestone conglomerates occur about 305 and 295 feet, respectively, above the Upper Freeport coal. The Ames and the Woods Run limestones occur about 340 and 240 feet, respectively, above the Upper Freeport coal in these localities. Therefore, considering the character and the position of this conglomeratic limestone, it would seem questionable to correlate it with either the Ames or the Woods Run limestones. Its presence could be accounted for by the fact that its composition suggests reworked material.

In a cut on Route 954, south of Smicksburg (Bd12), occurs a limestone conglomerate containing well-rounded greenish-gray limestone pebbles up to an observed largest dimension of one inch. The matrix is limestone stained with iron and containing calcite specks. The bed is 30 inches thick and is underlain by shale with alternating red beds. This limestone is about 180 feet above the Upper Freeport horizon or at the approximate horizon of the Pine Creek limestone. Obviously, it is reworked material and possibly from the Pine Creek.

ALLEGHENY GROUP

General Description

The Allegheny group is so named for its typical exposures and early study along the Allegheny Valley north of Pittsburgh. Because it contains many mineable coal beds, the Second Geological Survey of Pennsylvania called this group the Lower Productive coal measures.

The limits of the Allegheny group as customarily mapped extend from the top of the Upper Freeport coal to the base of the clay underlying the Brookville coal. It is unfortunate that the base of the Allegheny group is delimited by the Brookville coal and is so well established in the literature for the following reasons: The Brookville coal was originally named by Rogers in his summary report of the First Geological Survey of Pennsylvania, but he did not specify to what coal bed at Brookville the name was to be applied. Recent work by Graeber and Foose in the Brookville quadrangle [22] shows that the coal bed designated Brookville by Platt [23] is the Clarion coal. The lowest Allegheny coal at Brookville is poorly developed at its type locality, whereas at Conifer the bed attains a minable thickness. At many places elsewhere in Pennsylvania, several coal beds occur in the lower part of the Allegheny and the correlation of any one of them with the type Brookville is uncertain. The coal mapped by Graeber and Foose as the type Brookville agrees stratigraphically with the coal

[22] Graeber, C. K. and Foose, R. M., Geology and mineral resources of the Brookville Quadrangle, Pa.: Topog. & Geol. Survey Atlas no. 54, p. 50, 1942.

[23] Platt, W. G., Report of progress in Jefferson County: Pennsylvania Second Geol. Survey, vol. H6, 1882.

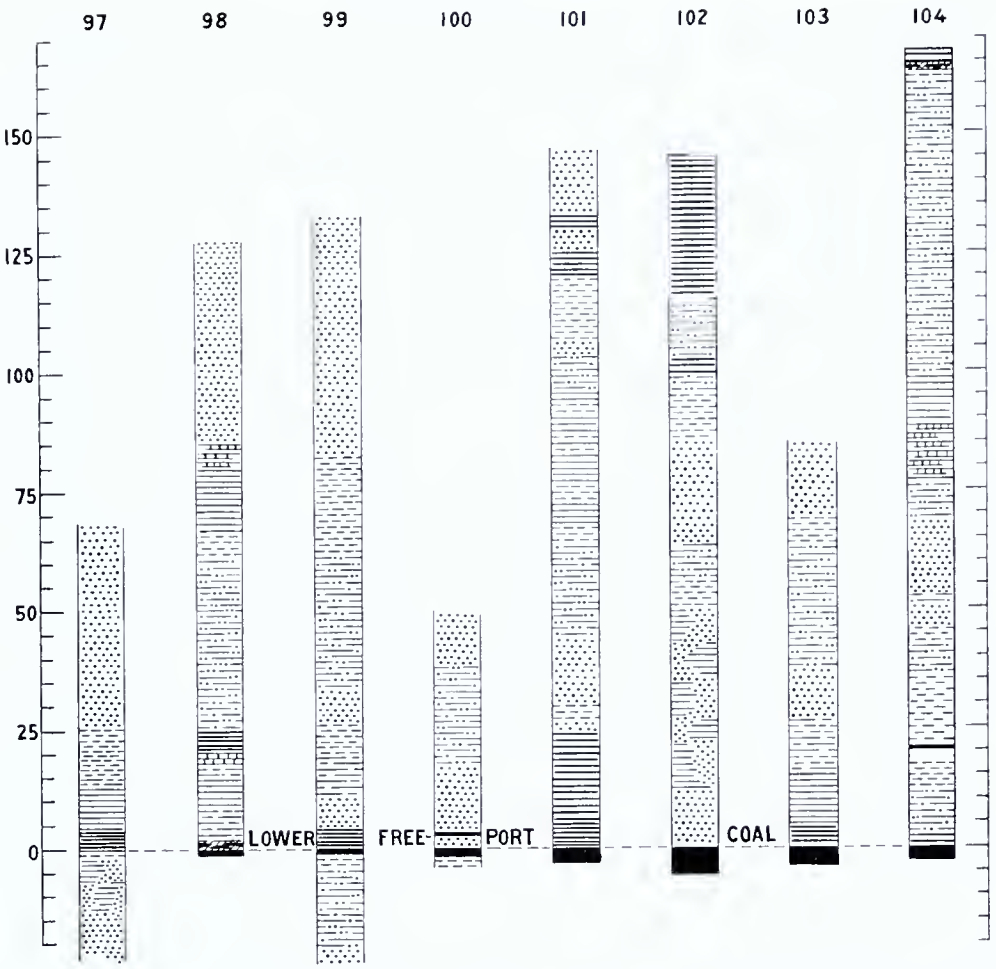


Figure 24. Sections from diamond core drill records showing lower Conemaugh and upper Allegheny groups.

Sections 97-103, Berwind-White Coal Co.; section 104, Hoffman Bros. Drilling Co.

97. Hole No. 29, Salsgiver farm, northeast of Valier. 98. Hole No. 30, Means farm, northeast of Valier. 99. Hole No. 31, Means farm, northeast of Valier. 100. Hole No. 33, Simpson farm, north of Sportsburg. 101. Hole No. 34, Simpson farm, north of Sportsburg. 102. Hole No. 38, Williams farm, north of Sportsburg. 103. Hole No. 28, Morris farm, north of Valier. 104. Hole on Fackner estate, northeast of Sportsburg, Punxsutawney quadrangle.

mapped as Brookville by Shaw and Munn in the Foxburg and Clarion quadrangles.[24] This coal has been traced across the adjoining Hilliards quadrangle by Sherrill and Matteson [25] and correlated with a coal in the Mercer formation, which coal and associated beds have been traced by Renick [26] from White's section in the Beaver Valley [27] and tied

[24] Shaw, E. W. and Munn, M. J., op. cit. p. 47.
[25] Sherrill, R. E. and Matteson, L. S., Geology of the Oil and Gas Fields of the Hilliards quadrangle: Pennsylvania Geol. Survey Bull. 122.
[26] Renick, B. Coleman, The correlation of Lower Allegheny-Pottsville section in western Pennsylvania: Jour. of Geol., vol. XXXII, no. 1, pp. 64-80, Jan.-Feb. 1924.
[27] White, I. C., Geology of Mercer County: Pennsylvania Second Geol. Survey, Report Q3, p. 28, 1878.

into the type Brookville at Brookville. Partly because of this stratigraphic condition, Dr. Ashley has proposed a revision of the Pennsylvanian System for Pennsylvania [28] and suggests the following reclassification:

Suggested reclassification of Pennsylvanian System

Pennsylvanian system
- Pittsburgh series
  - Monongahela group
  - Conemaugh group
  - Allegheny group (top of Upper Freeport or E coal to base of clay below Lower Kittanning or B coal)
    - Freeport member (top of Upper Freeport coal to top of Upper Kittanning or C coal)
    - Kittanning member (top of Upper Kittanning coal to base of Lower Kittanning clay)
- Pottsville series
  - Kanawha group
    - Clarion member (base of Lower Kittanning clay to base of clay below Lower Clarion, Craigsville, Pardee, or A coal)
    - Clearfield member (bottom of Clarion member to top of Connoquenessing sandstone. Includes Homewood sandstone where present in strength and Mercer beds).
    - Connoquenessing member
    - Sharon (Olean) member

Mississippian system

Studies of the Pennsylvanian System in western Pennsylvania reveal that the Lower Kittanning coal is, regionally, the most persistent coal in the Lower Allegheny group. Therefore, it seems logical that this horizon should form the lower limit of that group. However, until final acceptance of Ashley's proposed reclassification, the Brookville coal will be considered as the base of the Allegheny group in the Smicksburg quadrangle.

The thickness of the Allegheny group in the Smicksburg quadrangle ranges from 340 to about 370 feet (see pl. 4). In the southwest corner of Oliver and the northwest corner of Perry Townships, the Sprankle Mills anticline has elevated the group above drainage, and a thickness of 365 feet was calculated. Along Pine Run at McWilliams, which is just over the boundary in the Rural Valley quadrangle, the measured thickness of the Allegheny is 340 feet. At Milton, the Sprankle Mills anticline again elevates the group above drainage, and the thickness is about 350 feet. About one mile northwest of Hamilton a diamond drill hole has penetrated all of the Allegheny; and if the interpretation of the record is correct, the thickness is 370 feet. The record of another diamond drill hole south of Punxsutawney, which also went through all of the rocks, shows the Brookville coal to be absent. The Clarion coal, however, is 315 feet below the Upper Freeport; and, in the drill hole near Hamilton, the Brookville coal is 55 feet below the Clarion. Therefore, the thickness of the Allegheny group south of Punxsutawney would be also about 370 feet.

The main outcropping rocks in the northern part of the quadrangle and along the valley of Mahoning Creek belong to the Allegheny group. The upper members are exposed along the valley of Little Mahoning Creek. Most of the group is exposed on the Richmond

[28] Ashley, G. H., unpublished manuscript.

anticline southeast of Marion Center, and the Upper Freeport coal crops out for a short distance from Sagamore to near Plumville.

The Allegheny group has some characteristics in common wtih the Conemaugh. It is variable and composed mostly of shale and sandstone, with shale predominating. Sandstone is present locally throughout the group, and these sandstones are similar to those in the overlying group. Unlike the Conemaugh, the Allegheny contains valuable coal beds, more clays, and thicker and purer limestones.

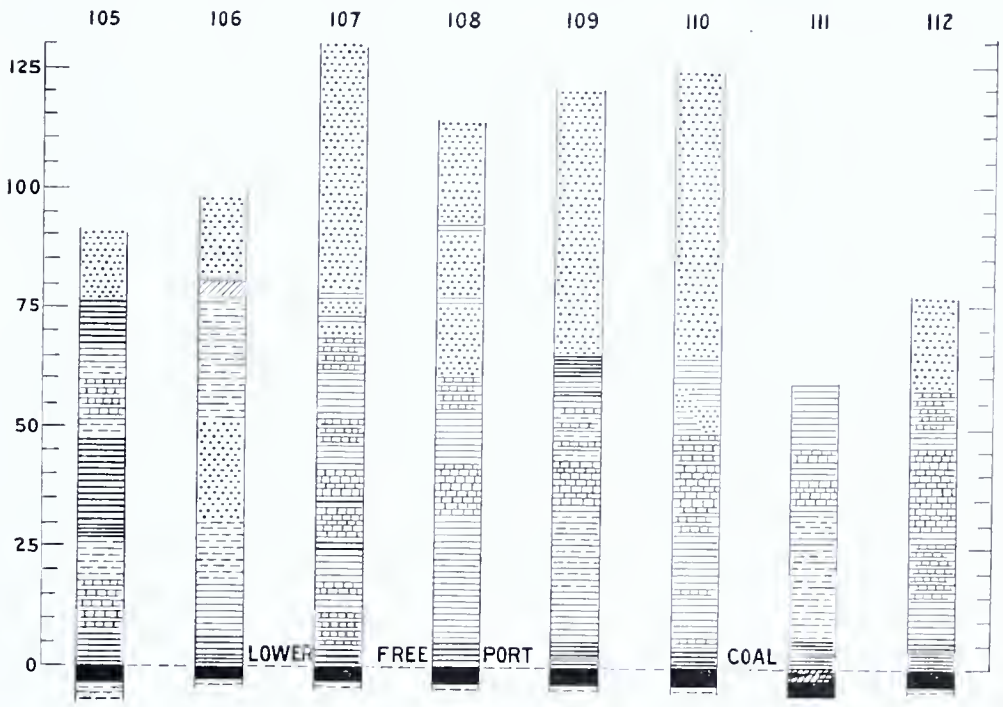


Figure 25. Sections from diamond core drill records of the Berwind-White Coal Co. showing lower Conemaugh and upper Allegheny groups.

105. Hole No. 26, McHenry farm, south of Frostburg. 106. Hole No. 27, McHenry farm, south of Frostburg. 107. Hole No. 24, Travis farm, north of Valier. 108. Hole No. 19, Travis farm, north of Valier. 109. Hole No. 23, Soxman farm, north of Valier. 110. Hole No. 22, Soxman farm, north of Valier. 111. Hole No. 20, Travis farm, north of Valier. 112. Hole No. 21, Soxman farm, north of Valier.

About ten coal beds, which are usually underlain by clays of more or less purity, at least three limestones, and two thin beds of iron ore occur in the group in this quadrangle. The important members have been given names for the places where they were first studied or are prominent, but are also known locally by other names. The coals of the Allegheny group in the Clearfield region are designated by letters,

which usage has been carried into this region. The important members of the Allegheny group and their position in the section are as follows:

Upper Freeport coal
Upper Freeport clay
Upper Freeport limestone
Bolivar clay
Butler sandstone
Lower Freeport coal
Lower Freeport clay
Freeport sandstone
Upper Kittanning coal
Johnstown limestone
Upper Kittanning sandstone
Middle Kittanning coals and clay
Middle Kittanning sandstone
Lower Kittanning coal
Lower Kittanning clay
Buhrstone iron ore
Vanport limestone
Scrubgrass coal
Clarion coals
Clarion sandstone
Craigsville coal
Brookville coal

Three of the coals, namely, the Upper Freeport, Lower Freeport, and Lower Kittanning, are more persistent and uniformly thicker. They are mined commercially and give this region its economic importance. The other coals in the group are generally thin or absent, but have mineable thicknesses locally and are worked for local consumption. Attention should be called to the fact that the Upper and Lower Freeport coals are not both well-developed in the same locality (see figs. 50, 63). In the northwestern and southwestern parts of the quadrangle where the Upper Freeport is well-developed, the Lower Freeport is generally thin or absent, and in the northeastern part of the quadrangle where the Lower Freeport reaches its maximum thickness for the area, the Upper Freeport appears not to have been deposited.

The Upper Freeport and the Vanport limestones are important as a source of agricultural lime. The Upper Freeport limestone has an excellent development and a wide distribution in this area. Because of its position in the lower part of the group, the Vanport limestone crops out only in the northern and northwestern parts of the quadrangle. The Lower Freeport limestone, which is an important member in other regions, is not prominent in this area. The Johnstown limestone is present locally, but thin and unimportant. Excellent beds of clay and clay shale occur, but have not been developed. Flint clay was observed only as nodules associated with the Upper Freeport and Vanport limestones. The sandstones have been worked in a small way.

For the purpose of detailed description the Allegheny group has been divided into three formations. The Freeport formation includes all the rocks lying between the top of the Upper Freeport coal and the top of the Upper Kittanning coal; the Kittanning formation includes the beds between the top of the Upper Kittanning coal and the base of the clay underlying the Lower Kittanning coal; and the Clarion formation extends from the base of the above formation to the base of the Brookville lower coal.

A brief discussion of the members will follow. The beds that are economically important at the present, and those that may have future economic importance, will be described in greater detail farther on in this report under Mineral Resources.

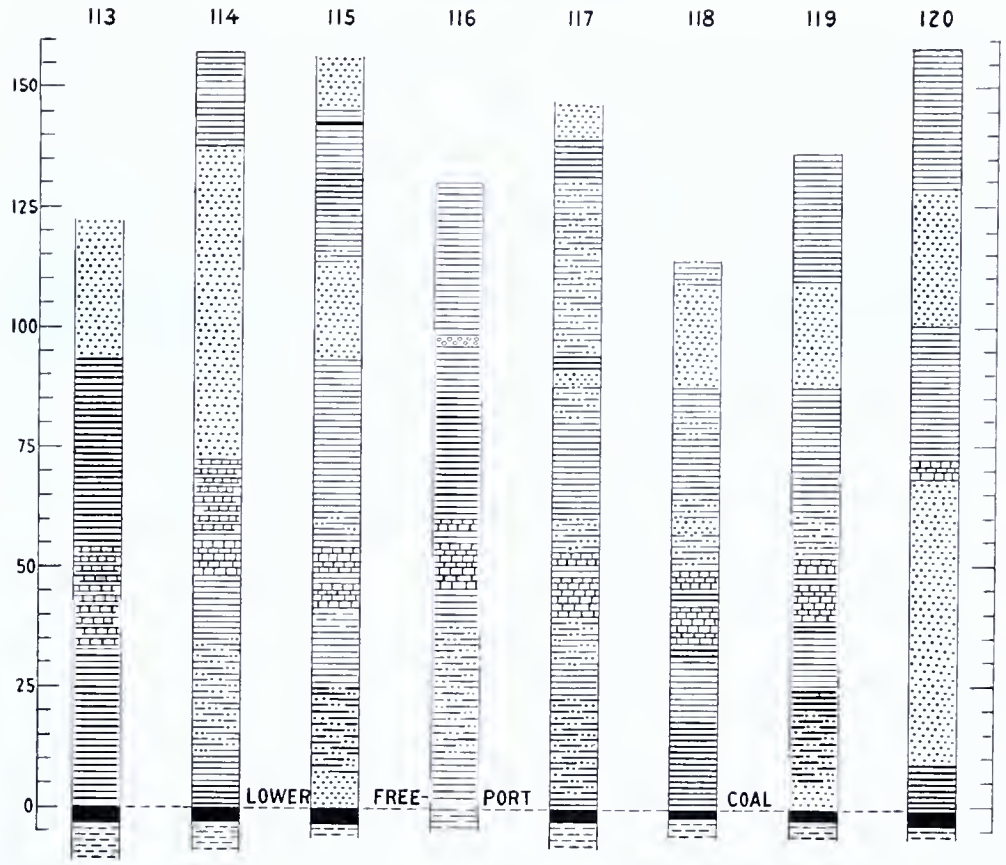


Figure 26. Sections from diamond core drill records of the Perry Hills Coal Co. showing lower Conemaugh and upper Allegheny groups.

113. Hole No. 5 Blose farm, northwest of Hamilton. 114. Hole No. 6 Blose farm, northwest of Hamilton. 115. Hole No. 7 Hull farm, northwest of Hamilton. 116. Hole No. 8 Eyler farm, northwest of Hamilton. 117. Hole No. 10 Eyler farm, northwest of Hamilton. 118. Hole No. 11 Eyler farm, northwest of Hamilton. 119. Hole No. 9 Eyler farm, northwest of Hamilton. 120. Hole No. 12 Cook farm, north of Hamilton.

Freeport Formation

Upper Freeport coal and clay. The Upper Freeport coal, which is the top member of the Allegheny group, is locally called the E or "Four-foot vein." This coal has been mined extensively in the areas of its better development, and most of the better and thicker coal has been worked out. It still is being mined commercially; numerous custom and country banks are working it for domestic use locally, and in 1943 and 1944 a large amount of this coal was produced by stripping.

The coal is commonly affected by "Rock rolls" or "faults," i.e., locally it has been partially and wholly eroded, probably by stream action, and other materials (usually sandstone) have, subsequently, been deposited unconformably on the surface. Excellent exposures of these erosional unconformities were observed in stripping operations.

Where these "faults" are numerous, they seriously affect mining, and consequently increase costs. Some projects were abandoned because of these conditions.

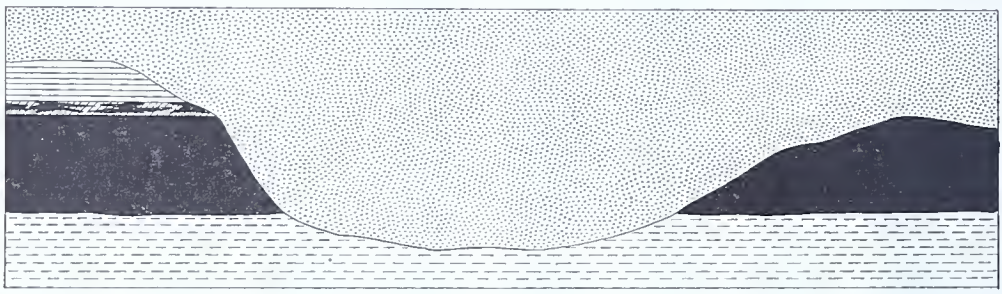


Figure 27. Sketch showing Mahoning sandstone "faulting" Upper Freeport coal, stripping, northwest of Timblin.

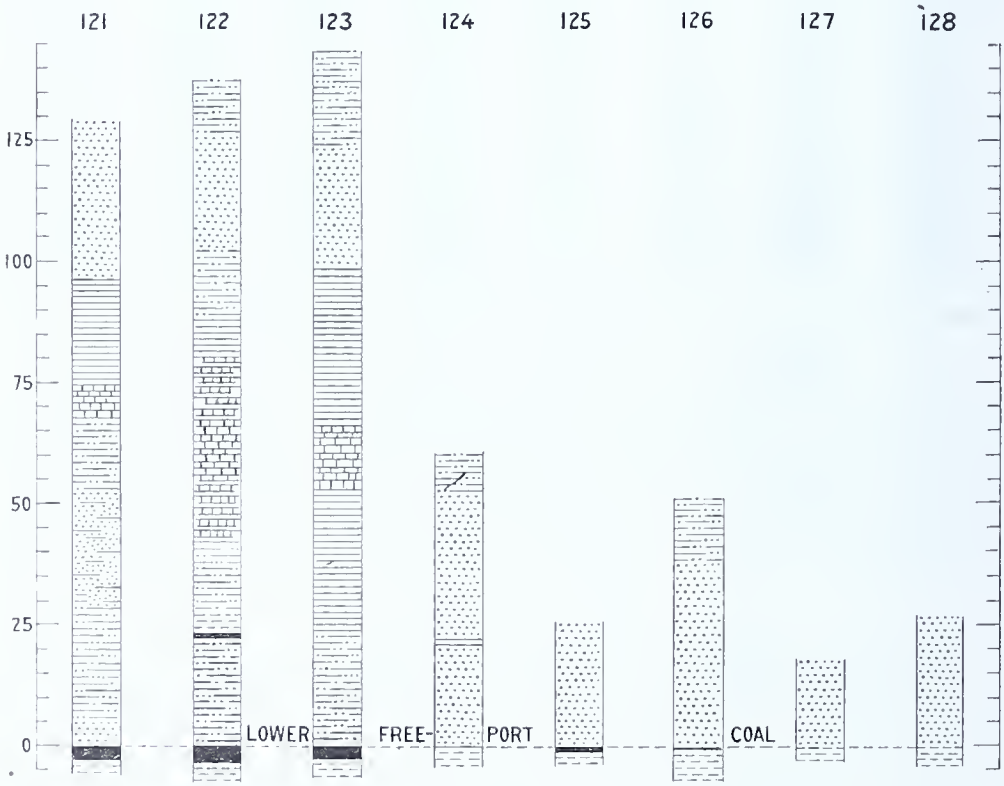


Figure 28. Sections from diamond core drill records of the Perry Hills Coal Co. showing lower Conemaugh and upper Allegheny groups.

121. Hole No. 13 Cook farm, north of Hamilton. 122. Hole No. 16 Cook farm, northeast of Hamilton. 123. Hole on Cook farm, northeast of Hamilton. 124. Hole No. 18 Hartwick farm, east of Hamilton. 125. Hole on Hartwick farm, east of Hamilton. 126. Hole on Hartwick farm, east of Hamilton. 127. Hole on Hartwick farm, east of Hamilton. 128. Hole on Hartwick farm, east of Hamilton.

The Upper Freeport normally is about 48 inches thick. It may be free of impurities, but commonly contains one or more binders or partings that are difficult to clean from the coal and, therefore, increase the ash content. The coal is characteristically separated from the roof by up to a known thickness of 24 inches of bony which comes down in mining; the roof is shale or sandstone.

The horizon of the Upper Freeport coal has wide distribution in the Smicksburg quadrangle, but only relatively small areas are known to contain coal of mineable thickness, and in many of these areas a considerable amount of coal has been eroded. In the northeastern part of the quadrangle, north of the axis of the Punxsutawney syncline, to just west of North Point, and thence roughly northward to the northern boundary of the quadrangle, the Upper Freeport coal appears to be missing. From many observations on the surface and from information obtained from numerous diamond drill records (see accompanying sections) it was concluded that the Upper Freeport had not been deposited. An explanation in some detail is given in the following description of the Upper Freeport limestone.

In the northwestern part of the quadrangle, and southward to about Dayton and Loop, the Upper Freeport coal has attained an excellent development and is rather persistent. The Mahoning sandstone cuts out the coal at numerous places, but the normal thickness is about 48 inches. The coal crops out in the hills and well above drainage; and where the Sprankle Mills and North Freedon anticlines have elevated the strata, large amounts of coal have been removed by erosion. Many commercial mines have worked the coal in this area, and custom and country banks continue to mine it for local use. In recent years much of this coal has been stripped and shipped to markets elsewhere.

Between Mahoning and Little Mahoning Creeks, the horizon of the Upper Freeport is deeply buried. This area has been prospected at many places with the diamond core drill (see accompanying sections) and the results indicate that the coal is generally thin or lacking.

The crop line of the Upper Freeport coal follows the valley of Little Mahoning Creek. The coal begins to thin just northwest of Smicksburg, and with the exception of a local thickness up to 48 inches north of Rossmoyne, not more than 10 inches of Upper Freeport was observed in the valley until near the eastern boundary of the quadrangle, where the coal again attains a mineable thickness.

The Richmond anticline has raised the horizon of the Upper Freeport coal above drainage in the southeastern corner of the quadrangle about Marion Center. Exposures are poor in this area and, although some prospecting had been done, no information was obtainable. Attempts have been made to work the coal at a few places, but the indications are that the bed is generally thin or lacking.

Data are meager on the Upper Freeport coal in the Elders Ridge syncline, south of Little Mahoning Creek, and westward from Pine Run to near North Branch Plum Creek. From what little was obtained in the nature of diamond core drill and gas well records, it seems doubtful if little or any mineable Upper Freeport coal underlies this area.

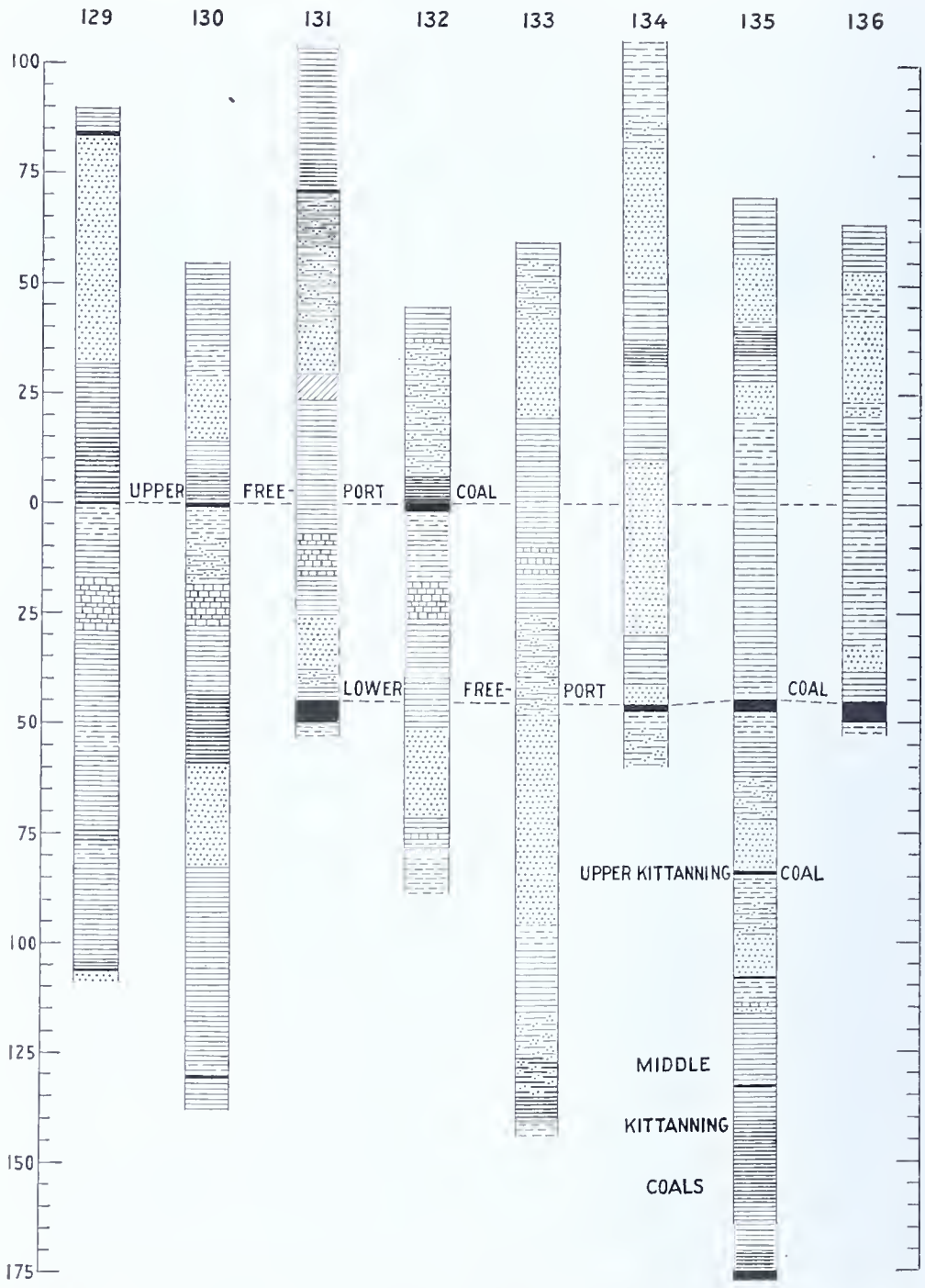


Figure 29. Sections from diamond core drill records showing lower Conemaugh and upper Allegheny groups.

Sections 129, 130, 132, Buffalo & Susquehanna Coal and Coke Co.; section 131, Pansy Coal Co.; section 133, Perry Hills Coal Co.; sections 134, 135, 136, Berwind-White Coal Co.

129. Hole No. 73, south of Trade City. 130. Hole No. 74, east of Trade City. 131. Hole No. 69 Chambers farm, south of Valier. 132. Hole No. 71, south of North Point. 133. Hole No. 14 Cook farm, north of Hamilton. 134. Hole No. 46 Simpson farm, south of Sportsburg. 135. Hole No. 44 McGregor farm, east of Sportsburg. 136. Hole No. 43 Alabran farm, northeast of Sportsburg.

The Upper Freeport coal is well developed about Sagamore, where it is being mined on a large commercial scale. The approximate limits of mineable coal in this locality extend nearly to Plumville, at least one mile south of North Branch Plum Creek, and northward to a little beyond Hoosicks Mill.

Little is known about the Upper Freeport coal where it is under considerable cover of Conemaugh rocks in the area north of Cowanshannock Creek to near Dayton and eastward to Little Mahoning Creek. Some prospecting is known to have been done, but no information could be obtained.

Clay usually underlies the Upper Freeport coal, and may be present where the coal is lacking, serving to mark the horizon. The clay is commonly of the plastic variety and is variable in composition. Thicknesses up to 10 feet are known, although greater thicknesses were reported. Occasional nodules and lenses of flint clay are associated with the plastic clay.

Upper Freeport limestone. The Upper Freeport (fresh water) limestone lies from immediately under to about 25 feet below the Upper Freeport coal, and is normally separated from it by clay, clay shale, or shale, or by a combination of these materials, which frequently contain lenses and nodules of limonite, and rarely concretions

Figure 30. Siderite concretions in interval between Upper Freeport coal and limestone, near Mottarns Mill.

of siderite. Although it appears to be wanting at a few places, this limestone is a well-developed and persistent bed throughout the Smicksburg quadrangle. Not only was it observed at numerous places

on the surface, but most of the diamond drill holes and many gas wells that have penetrated the horizon, particularly where it is below drainage, have found the limestone. It was, therefore, a valuable key rock in determining the geology of the region.

The Upper Freeport limestone weathers easily and does not crop out naturally; it was seen only in road cuts, occurring as nodules and boulders, and where it was mined or quarried. However, its position along the outcrop was located at many places by the residual iron ore that is commonly associated with the limestone.

The Upper Freeport limestone varies in thickness and in its position in the section. It is indicated on the records of some diamond drill holes as a solid bed up to 25 feet thick, or as a series of beds that differ in thickness, separated by clay or shale. Where the Upper Freeport coal is thin or missing, the limestone may be thicker or entirely lacking, the latter condition probably being due to erosion.

As indicated in diamond core drill records and from direct observations in the northeastern part of the quadrangle where the Upper Freeport coal is missing, the limestone occurs at various positions in the section. It not only may occupy the expected horizon of the Upper Freeport coal, but may extend upward beyond that horizon into what

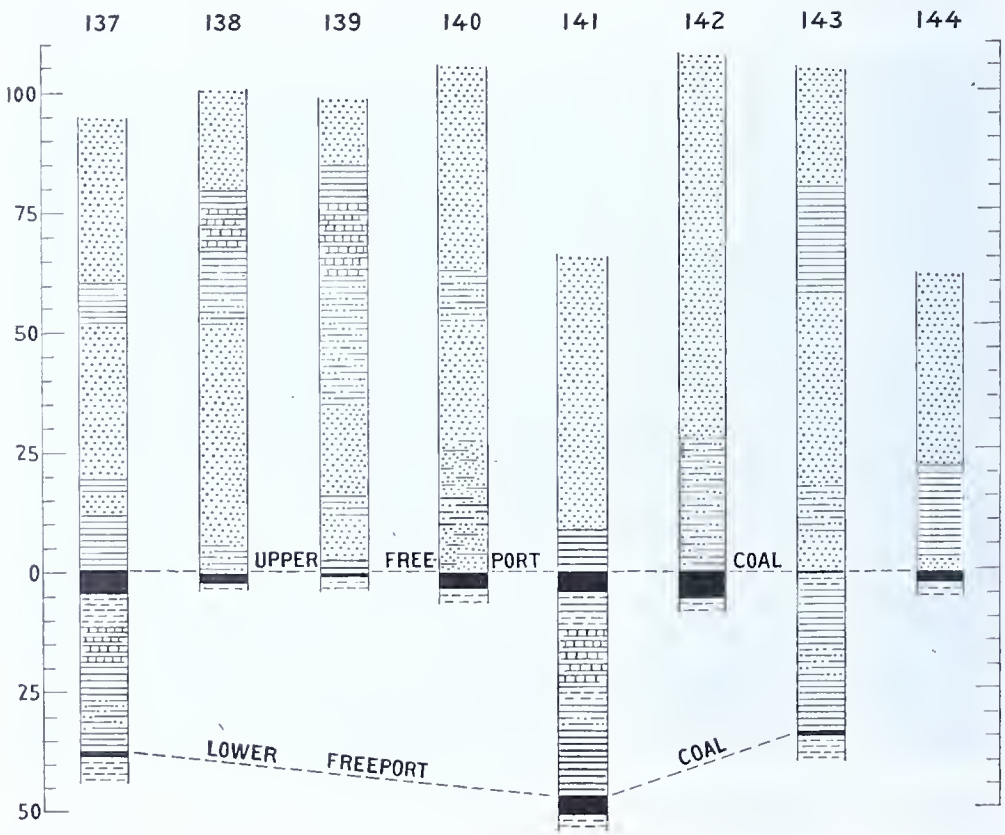


Figure 31. Sections from diamond core drill records of the Gilbert Coal Co. showing lower Conemaugh and upper Allegheny groups.

137-140, 142-144. Holes on McClure farm, south of Dora, exact locations unknown. 141. Hole No. 3 McClure farm, south of Dora.

should be considered as the lower part of the Conemaugh group (see accompanying sections). Time did not permit a detailed study of this stratigraphic problem, and the following is offered only as a suggested explanation.

After a period of relatively deeper fresh-water conditions, which were almost universal in western Pennsylvania, and in which calcareous deposits accumulated to form the Upper Freeport limestone, there followed a period of almost universal swamp conditions, in which large quantities of debris from dense vegetation accumulated, were compacted and buried, and later became what is now called the Upper Freeport coal. Locally, however, and probably because of differential subsidence, deeper water conditions favorable for deposition of limy material continued during and a relatively short time after swamp conditions became prevalent elsewhere. As will be noted in the accompanying sections, deposition of limy sediments appears not to have been uniform; that where limestone occurs in one section, the corresponding interval in another section is composed of either clay, shale, or sandstone. Aside from other possible factors, this lack of uniformity in deposition is thought to be due in part to deposition on an unevenly eroded surface, and in part to local interruption in deposition of calcareous material; which latter factor may also account for the alternating beds of limestone, clay, and shale at some places.

Assuming that the above hypothesis is acceptable, it could then be inferred that the absence of the Upper Freeport coal in the northeastern part of the quadrangle is due to nondeposition.

The Upper Freeport limestone is generally heavy-bedded to massive, and shaly in part; or, as indicated in some diamond drill records, its place is occupied by limy shale. The limestone is hard and fine-grained, with occasional coarsely granular beds; the fracture is irregular to subconcoidal. Calcite spots, averaging about one-fourth inch, are common on a freshly fractured surface. The colors are light-gray, bluish-gray and grayish-blue, weathering to whitish, buff or brown. Platt [29] has described the Upper Freeport limestone in this region as containing minute fossil univalve shells. It is not doubted that Platt's observations are correct, but fossils were not seen in any specimens examined by the writer.

Numerous pits and drifts have been opened on the Upper Freeport limestone in the northern part of the quadrangle, and it is burned in an open heap and used for agricultural purposes locally. Two small plants are mining and pulverizing the limestone for custom trade.

The following typical section of the Upper Freeport limestone is exposed on the bluff along Little Mahoning Creek east of Dayton (Ac34).

[29] Platt, W. G., op. cit., p. 5.

Section east of Dayton

	Ft.	in.
Sandstone, heavy-bedded, Mahoning	10+	0
Sandstone, shaly, Mahoning	3	0
Shale, sandy	1	8
Bony coal	0	10
Coal, lenses of "mother of coal", Upper Freeport	3	10
Flint clay, light, sandy in part	2	0
Clay, light, sandy	2	0
Flint clay, grades downward to white sandstone with limonite nodules	9	0
Sandstone, fine-grained, micaceous	0	5
Clay, dark	0	6
Clay, bluish-gray	0	8
Clay, white, plastic	0	1
Clay, greenish, sandy, limonite nodules	4	0
Limestone, bluish-gray, a few thin shale partings	12	0
Clay	1	

Bolivar fire clay. The Bolivar fire clay was named for that place along the Conemaugh River in northeastern Westmoreland County. In some of the early reports, this bed was confused with clay underlying the Upper Freeport coal, but its original use applied to the clay underlying the Upper Freeport limestone.

As was noted at outcrops and revealed in the records of diamond drill holes (see accompanying sections), clay is occasionally present under the Upper Freeport limestone in the Smicksburg quadrangle. The thickness is variable up to a maximum record of 12 feet. Flint clay occurring in nodules is commonly associated with it. The composition of the clay was not determined, but its economic value is doubtful.

Butler sandstone. The Butler sandstone was first described by I. C. White [30] in the county by that name. This member of the upper Allegheny group is developed at various places throughout the Smicksburg quadrangle. It generally is platy to massive and cross-bedded, is medium- to coarse-grained with occasional lenses of fine conglomerate. Its color varies through shades of gray and brown. The sandstone commonly occurs as a single bed, but frequently is split into two or more parts, usually with shaly partings. The base commonly lies unconformably on an eroded surface.

The Butler sandstone is abnormally developed, locally, in the northeastern part of the quadrangle, where it frequently fills the interval between the horizons of the Upper and Lower Freeport coals; in places it has replaced those horizons and extends beyond them (see accompanying sections). The thickness of the sandstone varies; the known maximum is 60 feet.

The Butler sandstone crops out and is well displayed for some distance on the road along Mahoning Creek from the eastern boundary of the quadrangle; it is also prominent in the vicinity of Hamilton, where at some places it is particularly massive and resistant, as is indicated by the large boulders on the hillside.

[30] White, I. C., op. cit., p. 47.

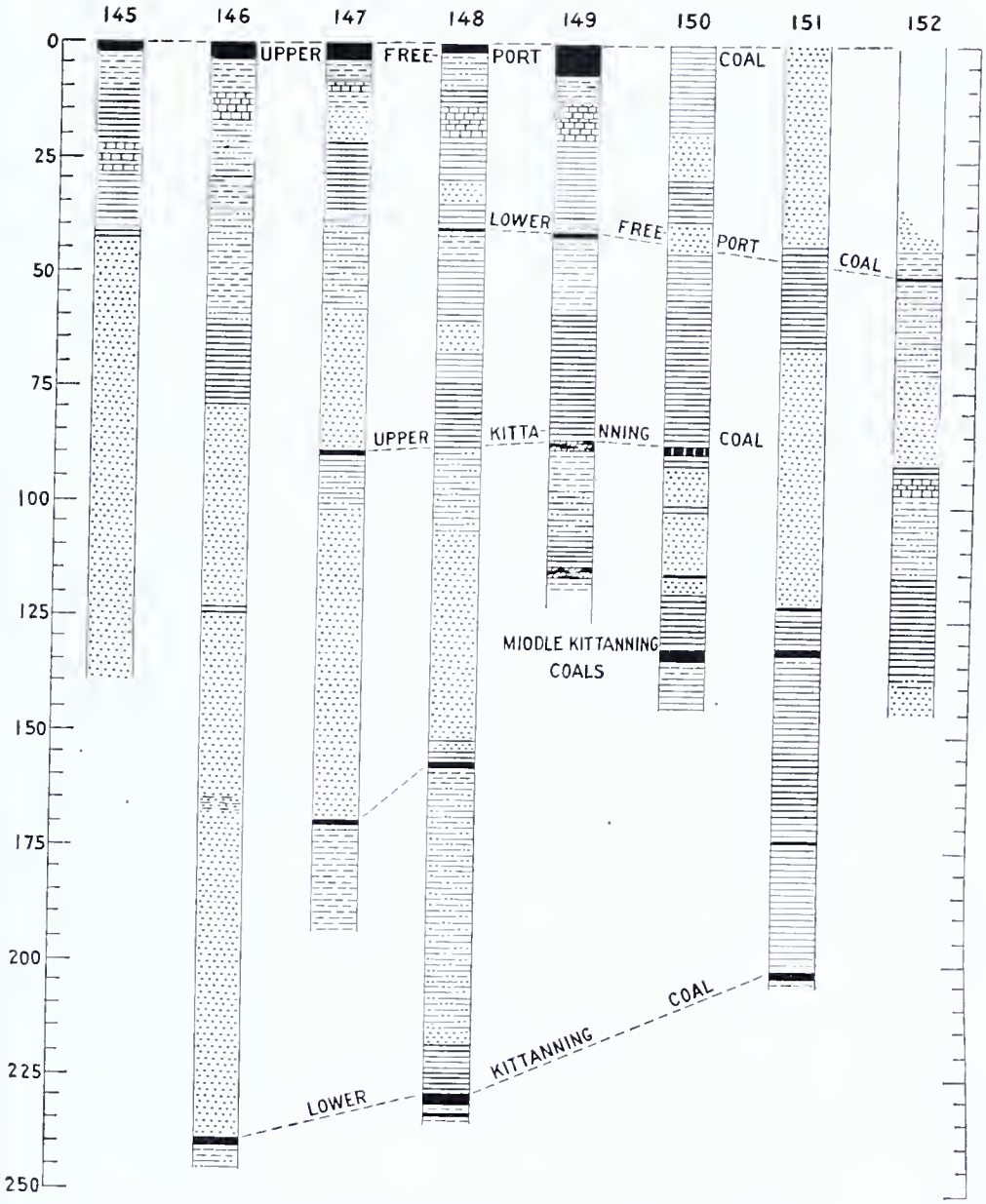


Figure 32. Sections from diamond core drill records showing the Allegheny group between Upper Freeport and Lower Kittanning coals.

Section 145, Buffalo, Rochester and Pittsburgh Coal Co.; sections 146-151, Buffalo & Susquehanna Coal and Coke Co.; section 152, courtesy of Mr. Stephenson of McCormick.

145. Hole No. 83 Marshall farm, northeast of Barnards. 146. Hole No. 110, east of Hoosicks Mill. 147. Hole No. 113, northeast of Sagamore. 148. Hole No. 126, south of Sagamore. 149. Hole No. 109 Marshall farm, northwest of Plumville. 150. Hole No. 84, Neff farm, west of Denton. 151. Hole No. 78, southeast of Trade City. 152. Hole No. 79, Stephenson farm, at McCormick.

Lower Freeport coal. The Lower Freeport or D coal is known locally as the "Three-foot vein." This is the Moshannon coal of the Clearfield region. Its position below the Upper Freeport ranges from about 30 to 60 feet and averages about 45 feet.

As a general rule, the Lower Freeport coal is fairly free from impurities and of excellent quality; one or more partings are frequently present, but do not persist far in any direction. Irregular lenses and occasional balls of "sulphur" (pyrite) are generally scattered throughout the bed. A few inches of bony or shaly cannel coal, or both, occur on top; or the coal may be overlain by a variable thickness of shale. The coal may also be in contact with the Butler sandstone, which has cut into and through the coal at various places. Clay squeezes are of common occurrence in the Lower Freeport. Excellent examples of them were observed in underground mining and stripping operations in the northeastern part of the quadrangle. Locally, the Lower Freeport is split into two or more benches as much as 20 feet apart and separated usually by shale.

The best development of the Lower Freeport coal in the quadrangle occurs in the northeastern part in the Frostburg, Valier, and Hamilton districts, where the Upper Freeport is missing (fig. 63). It is an exceptionally good coal in this area and has fine coking qualities; also, it attains a known maximum thickness of 10 feet for the quadrangle. Large-scale commercial mines had worked the Lower Freeport in this area; in fact, it was the first relatively large-scale commercial development in the quadrangle, and contributed greatly to the economic importance of the region. However, the bed is rapidly becoming depleted; only one commercial mine was operating when this survey was made. Stripping operations began in 1941 and up to and during 1945 produced large tonnages of this coal.

Westward from the area of its best development, the Lower Freeport coal becomes thinner and is erratic in occurrence, although it has workable thickness locally and is mined in custom and country banks. The coal is well developed at a few places in the southeastern corner of the quadrangle. Commercial mines had worked it at Marion Center where it appears to be fairly good and has a known maximum thickness of 56 inches. Elsewhere in the quadrangle, the Lower Freeport horizon is mostly below drainage, but from observations in the valley of Little Mahoning Creek, where the outcrop is generally above water level, and as disclosed by diamond core drilling where the horizon is buried, the coal is either thin or lacking.

Lower Freeport clay and limestone. Plastic clay nearly always is present under the Lower Freeport coal. The composition and character of the bed vary from place to place. It may be firm or soft at outcrop, dark and carbonaceous, or very light. It ranges considerably in thickness, with an indicated maximum of 12 feet. The clay often persists where the coal is not present and, therefore, marked the horizon (see accompanying sections).

The position of the Lower Freeport limestone is immediately under the Lower Freeport coal where it occurs in other regions. I. C.

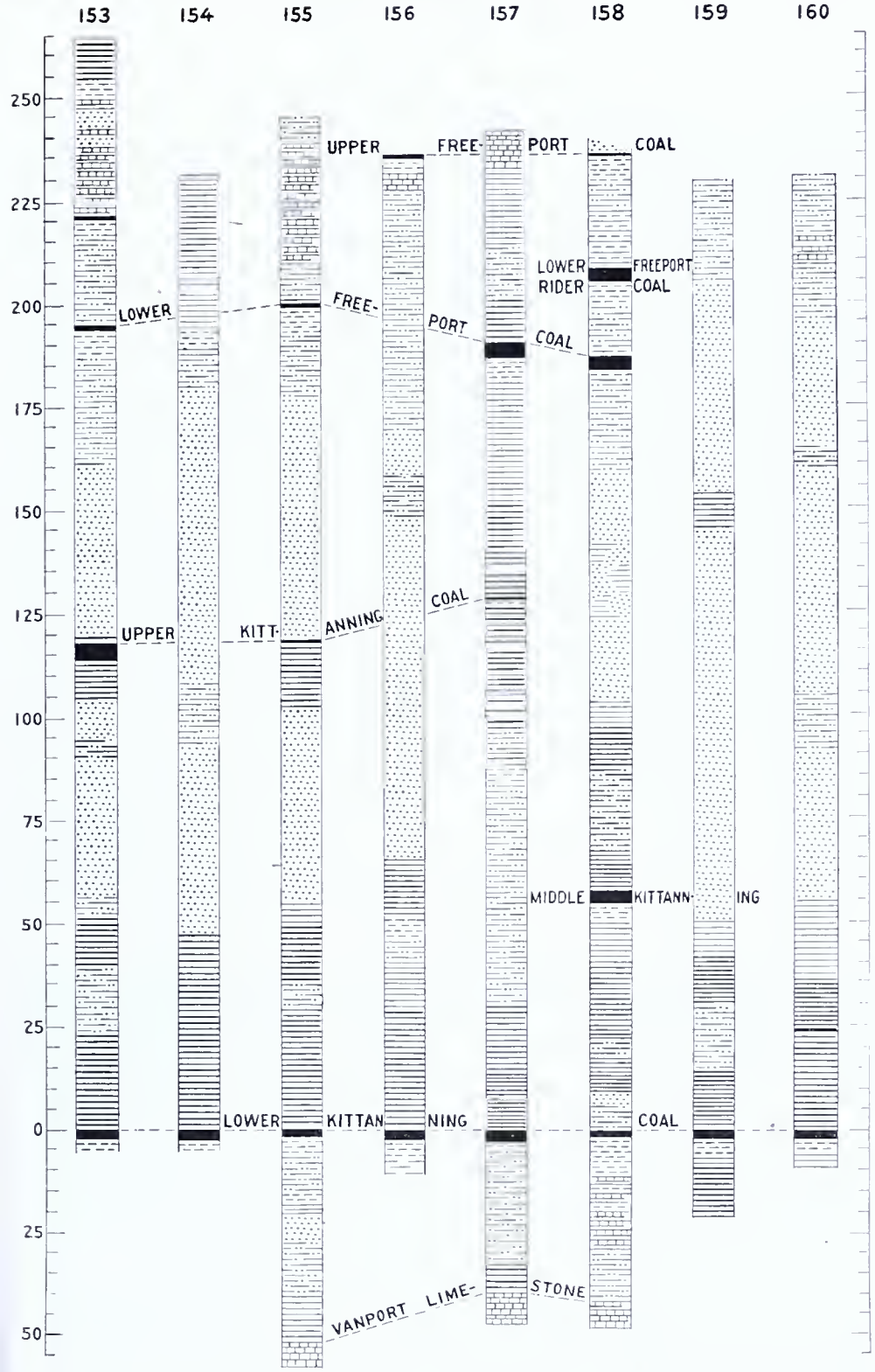


Figure 33. Sections from diamond core drill records showing the Allegheny group between Upper Freeport coal and Vanport limestone.

Sections 153-156, Dora Coal Co.; section 157, Perry Hills Coal Co.; section 158, Hoffman Bros. Drilling Co.; sections 159-160, Berwind-White Coal Co.

153. Hole on Smathers farm, northeast of Ringgold, Brookville quadrangle. 154. Hole on Smathers farm, northeast of Ringgold, Brookville quadrangle. 155. Hole No. 1 Smathers farm, northeast of Ringgold. 156. Hole No. 2 Shaffer farm, east of Ringgold. 157. Hole No. 4 Blose farm, northwest of Hamilton. 158. Hole on Fackner estate, east of Sportsburg, Punxsutawney quadrangle. 159. Hole on Carr farm, east of Sportsburg, Punxsutawney quadrangle. 160. Hole on Hawk farm, east of Sportsburg, Punxsutawney quadrangle.

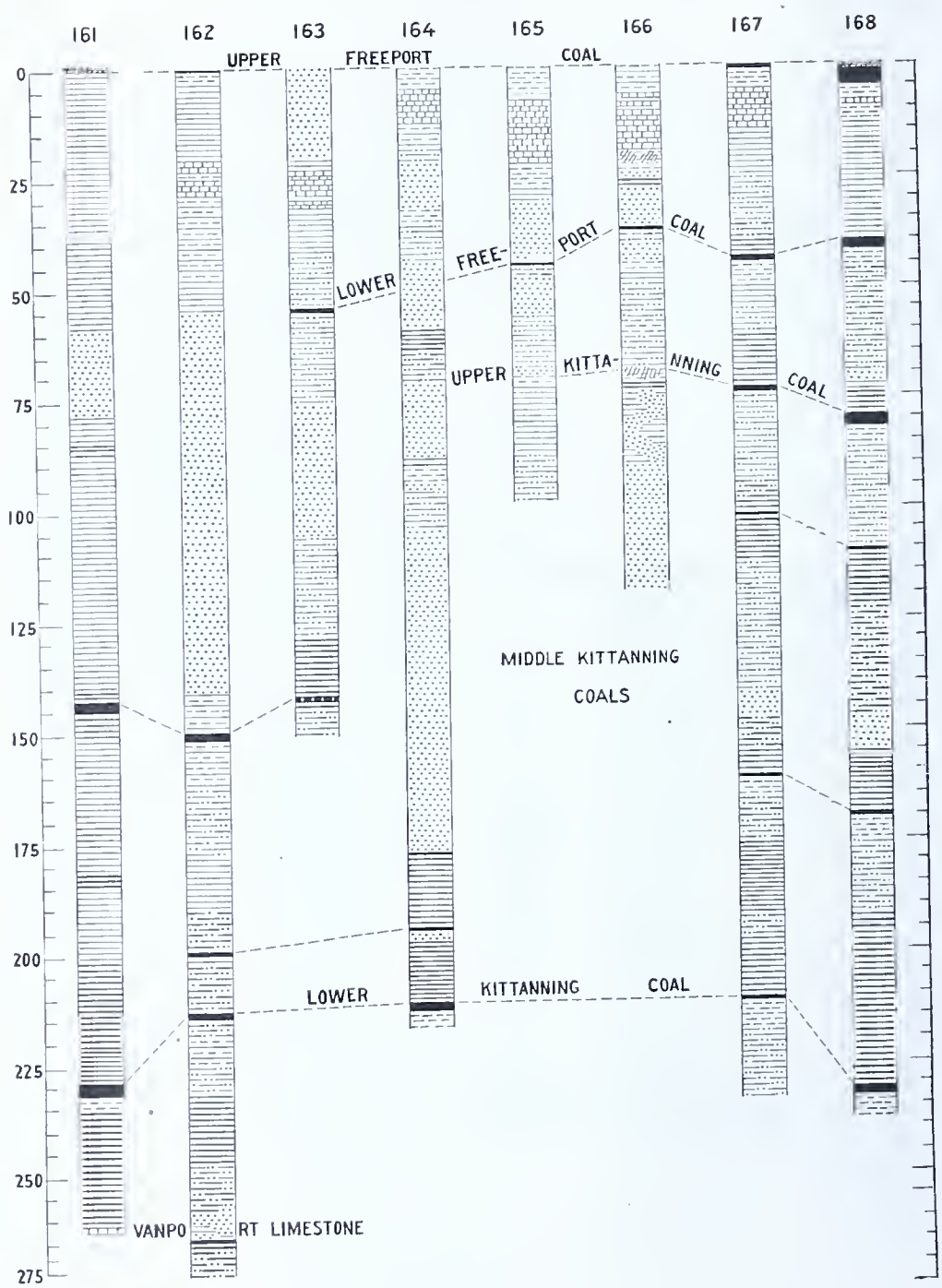


Figure 34. Sections from diamond core drill records showing the Allegheny group between Upper Freeport coal and Vanport limestone.

Sections 161, 162, Buffalo & Susquehanna Coal and Coke Co.; sections 163-168, Clearfield Bituminous Coal Co.
161. Hole No. 70, north of Trade City. 162. Hole No. 75, northwest of Marchand. 163. Hole on White farm, southeast of Sportsburg, Punxsutawney quadrangle. 164. Hole on Martin farm, east of Covode, Punxsutawney quadrangle. 165. Hole on North farm, southeast of Covode, Punxsutawney quadrangle. 166. Hole on Coy farm, southeast of Covode, Punxsutawney quadrangle. 167. Hole on States farm, east of Marchand, Punxsutawney quadrangle. 168. Hole on Calderwood farm, southeast of Marchand, Punxsutawney quadrangle.

White [31] named it the Butler limestone in Butler County, and described it as an impure ferruginous bed 5 feet thick. This limestone appears not to have been deposited in the Smicksburg quadrangle as it was nowhere observed at outcrop. However, a diamond drill hole on the Weaver farm, two miles east of Plumville (fig. 19, Sec. 58) encountered limestone at about 55 feet below the Upper Freeport coal which would normally be near the stratigraphic horizon of the Lower Freeport limestone. The record also shows a series of limestone beds extending from about 20 to 80 feet below the Upper Freeport coal. Since the Lower Freeport coal is lacking, it may be only an expanded Upper Freeport limestone section.

Freeport and Kittanning sandstones. The sandstone occurring between the Lower Freeport and the Upper Kittanning coals is called the Freeport sandstone; the sandstone between the Upper Kittanning and Middle Kittanning coals, the Upper Kittanning sandstone; and the sandstone between the Middle Kittanning and Lower Kittanning coals, the Middle Kittanning sandstone. The Lower Kittanning sandstone is between the Lower Kittanning coal and the Vanport limestone.

Sections obtained on the surface and from diamond core drilling (see accompanying sections) show that the interval between the Lower Freeport and Lower Kittanning coals at some places is predominantly composed of shale, at other places mostly of sandstone. Also, at some places, sandstone occupies the stratigraphic position of the coals or other beds that mark the normal limits of the sandstones. Where a sandstone is thicker and extends stratigraphically beyond its normal limits, it has, in this report, been called by the name of the stratigraphic unit that is equivalent to the limits wherein the base of a thicker sandstone occurs. However, at many outcrops, the base of a

[31] White, I. C., Pa. Second Geol. Surv. Rept. Q, p. 94, 1878.

Figure 35. Carbonized plant remains in Freeport sandstone near Loop.

sandstone could not be found, and in such cases, the partially exposed sandstone was correlated with the member that normally occupies the corresponding part of the section.

The Freeport, Upper and Middle Kittanning sandstones have similar characteristics. Their usual colors are gray, tan, and greenish. Muscovite flakes are present and locally abundant, particularly where the sandstones are shaly or thin. These sandstones commonly are medium-grained, but are coarse-grained and occasionally pebbly where massive. Cross-bedding is also common, and occasional inclusions of carbonized plant remains were noted.

The Freeport sandstone is developed at various places in the northeastern part of the quadrangle. Its massive character is displayed by the large boulders that occur northeast of Frostburg and south of B.M.1554; north of Fordham, along the road northeast from B.M.1373, it is about 50 feet thick, medium-grained and cross-bedded.

The Freeport and Upper Kittanning sandstones occur along Mahoning Creek at various places. They are particularly prominent and make the bluffs about Loop. These sandstones were also observed about Milton. The Freeport sandstone is well displayed southwest of Milton on the road ascending the hill toward Dayton, and is about 60 feet thick. Northeast of Milton along the road following Foundry Run, the Upper Kittanning sandstone is massive and coarse-grained to conglomeratic, as was evidenced by float and partial exposures. The Freeport, Upper and Middle Kittanning sandstones are present along some of the roads that ascend the hills from Pine Run, in the north-

Figure 36. Valley of Mahoning Creek east of Loop, showing Freeport sandstone in bluff.

Figure 37. Freeport sandstone, near Loop.

western part of the quadrangle. The Freeport and Upper Kittanning members are more persistent and better developed. The Lower Kittanning sandstone is rarely present and where it was noted, it is only a few feet thick.

Kittanning Formation

Upper Kittanning coal. The Upper Kittanning or C′ coal has an average range from 80 to 100 feet below the Upper Freeport horizon. This bed is erratic in occurrence in the Smicksburg quadrangle. It is generally thin and its position in the section is frequently occupied by other material. Numerous outcrops of this coal were observed and it was found in some diamond core drill holes. It has a workable thickness in some areas, and has been mined for domestic fuel. Its best known development is in the northwestern part of the quadrangle, south of New Salem, where it has an observed maximum thickness of 8 feet 3 inches, the lower 4 feet of which is a variety of cannel coal known as canneloid or "bird's-eye."

The Upper Kittanning is also workable at a few places in the vicinity of Milton, and up to 48 inches of coal was noted, but was reported to be very spotty in occurrence. This coal appears to be fairly persistent and is up to 30 inches thick in the area south of Marion Center where it had been worked for local use. The Upper Kittanning had been worked and prospected at several places north and northwest of Frostburg, and thicknesses up to 30 inches were reported. Plastic clay of variable thickness is occasionally present under the coal, and at some places marks the horizon where the coal is missing.

The Upper Kittanning coal and associated strata are shown graphically in the accompanying sections. Because this coal may have future economic possibilities, it is discussed in detail under Mineral Resources.

Johnstown limestone. The Johnstown limestone, known also as the Johnstown cement bed, was named by H. M. Chance [32] for its occurrence at Johnstown in Cambria County. This member of the Allegheny group lies immediately below the Upper Kittanning coal and is normally separated from the coal by clay and shale. The Johnstown limestone is generally absent in the Smicksburg quadrangle. It was seen in outcrop only at a few places. Most of the sections obtained from diamond core drilling do not show limestone at this horizon (see accompanying sections).

It was found in the southeastern part of the quadrangle in the area south of Marion Center where it seemingly is persistent. About one mile southeast of Marion Center (Ff25), this limestone had been dug and burned for local use; the workings were slumped and nothing could be learned about the quality and thickness of the limestone. Limestone was reported to underlie the Upper Kittanning coal at various other places in this area.

The Johnstown limestone is partially exposed along the Baltimore & Ohio Railroad west of Trade City Station (Dd4). A partial outcrop of this bed was located south of Hamilton (De5). The best exposure found occurs north of Valier (Eb53). At that place the Johnstown limestone is 30 inches thick, hard, compact, and impure, and contains calcite, and chert nodules. The following section was obtained:

Section north of Valier

	Ft.	in.
Shale	10	
Coal, Upper Kittanning	1	9
Clay shale	1	8
Limestone, Johnstown	2	6
Shale, greenish, sandy		

Middle Kittanning coals. At least three generally thin and nonpersistent coal beds occupy the interval between the Upper Kittanning and Lower Kittanning coals in the Smicksburg quadrangle (see accompanying sections). It is, therefore, problematical which one of these beds corresponds to the type Middle Kittanning; also the correlation of these beds with one another for any distance within the quadrangle is uncertain. The name Middle Kittanning in this report, is necessarily applied to any coal occurring within the interval delimited by the horizons of the Upper Kittanning and Lower Kittanning coals.

It seems apparent that during this period of deposition, swamp conditions were of relatively short duration, and were repeated at different times and places. Interruption in the continuity of the coal beds was probably due in part to the existence of higher areas in the swamps and to subsequent erosion of the coals, as was inferred from lumps of coal in the associated sandstones.

[32] Chance, H. M., Pennsylvania Second Geol. Survey Rept. VV, p. 43, 1880.

Numerous outcrops of the Middle Kittanning coals were seen in the northern part of the quadrangle where that part of the Allegheny group is above drainage. Most of the observed outcrops were blooms and the true thicknesses of the coals could not be measured. These coals have been worked at various places in a small way for local domestic use. Although data on the Middle Kittanning coals in the quadrangle are meager, from what has been observed, it seems doubtful that any of them have present commercial interest. However, thorough prospecting may disclose some of these beds to have a uniform and workable thickness under large enough areas to constitute a future reserve.

Lower Kittanning coal. The Lower Kittanning or B coal is also called the "Thirty-inch vein" in this region. Its position below the Upper Freeport coal horizon ranges from 200 to 250 feet. The depths from the Upper Freeport horizon to the Lower Kittanning coal in various parts of the quadrangle are as follows: western boundary near Pine Run, 200-210 feet; north and northeast of Timblin, 230 feet; south of Timblin, 210 feet; vicinity of Ringgold, 245 feet; north of Grange, 235 feet; Mahoning Creek at eastern boundary, 230 feet; Hamilton, 250 feet; Milton, 200 feet, and south of Sagamore, 230 feet.

The Lower Kittanning coal in the Smicksburg quadrangle maintains many of the characteristics described in the reports on the geology of western Pennsylvania. It is very persistent and has a fairly uniform thickness of about 30 inches, but extremes from 12 to 48 inches are known. Nonpersistent binders and partings occur, particularly in the upper part. The coal is generally of good quality, but the ash and sulphur content increase locally. Lenses and spheroidal aggregates of "sulphur" (pyrite and marcasite) characterize the bed. It is normally overlain by a variable thickness of dark to black shale, which may be fissile in part. An occasional layer of bony up to 13 inches thick was also noted at the top. Sandstone rarely is in contact with the coal and, so far as is known, the coal is not affected by rock rolls. The Lower Kittanning coal and its relation to other beds is shown in the accompanying sections.

The outcrop of the Lower Kittanning is not extensive in this quadrangle, and is confined almost entirely to the northwestern part, where the coal has undergone relatively large commercial mining. The crop line follows along Pine Run and extends well up its tributaries; the Sprankle Mills anticline has raised the horizon of the Lower Kittanning well above drainage, and it crops out in the hills north of Grange and about Milton. Elevated by the Richmond anticline in the southeastern part of the quadrangle, the Lower Kittanning horizon appears just above drainage for a short distance along Little Mahoning Creek, Pickering Run, and in an unnamed run in the extreme southeastern corner.

The Lower Kittanning horizon is under considerable cover in the rest of the quadrangle. A few scattered diamond core drill tests have been made, and almost invariably have found Lower Kittanning coal present and ranging in thickness from 20 to 44 inches. Coal is also indicated at this horizon on numerous records of wells that were

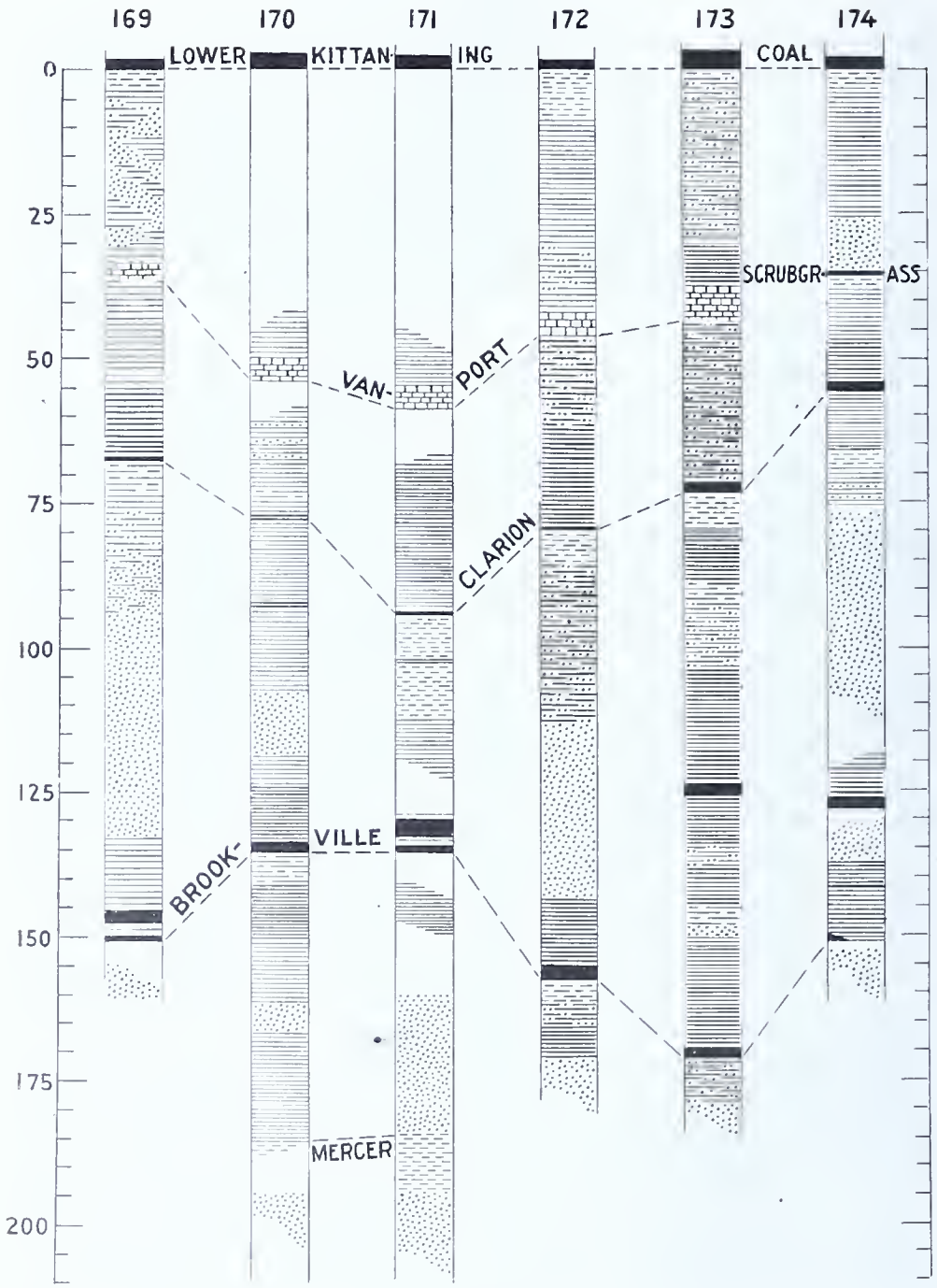


Figure 38. Sections of lower Allegheny group and upper Pottsville series.

169. Sections long Pine Run near eastern boundary in Rural Valley quadrangle. 170. Section 2.5 miles east of Ringgold. 171. Section 1.7 miles north of Grange. 172. Section from record of diamond core drill hole on Fackner estate, northeast of Sportsburg, Punxsutawney quadrangle. 173. Section from record of diamond core drill hole (4) on Blose farm, northwest of Hamilton. 174. Section southwest of Milton.

drilled in search of natural gas. It seems not improbable, therefore, that the Lower Kittanning has a wide distribution in this area, and may be considered as a possible reserve for the future.

The Lower Kittanning coal is nearly always underlain by plastic clay, with a known maximum thickness of 10 feet.

Clarion Formation

Vanport limestone and Buhrstone iron ore. The Vanport (marine) limestone was named by I. C. White [33] because of its excellent development along the Ohio River at Vanport in Beaver County. In the earlier reports it was called the Ferriferous limestone, because immediately on its top there generally occurs a few inches to a few feet of impure iron ore in lenses or nodules, consisting of siderite, limonite, or hematite. This bed was called the Buhrstone ore because cherty material is often associated with it. This iron ore was once used extensively in small blast furnaces in western Pennsylvania, but lost its economic importance long ago.

In the Smicksburg quadrangle, the Vanport limestone lies from 30 to 60 feet below the Lower Kittanning coal, which interval is normally filled with shale, clay-shale, and clay, with occasional lenses of sandstone. The best exposure of this part of the Allegheny section in the quadrangle occurs in the Pittsburgh and Shawmut Railroad cut

Figure 39. Section in railroad cut at Dora showing strata between Lower Kittanning coal and Vanport limestone.

at Dora. This interval was also revealed in three diamond core drill holes (fig. 33, secs. 155, 157, 158).

The color of the Vanport limestone is light to dark bluish-gray; its weathered surface is light gray to whitish, and is commonly iron-stained. It is hard, dense, and breaks with an irregular to sub-

[33] White, I. C., op. cit., pp. 60-63.

concoidal fracture. The limestone is abundantly fossiliferous, containing a marine fauna consisting of brachiopods, corals, pelecypods, gastrapods, and broken crinoid stems. Raymond [34] has listed numerous species from the Vanport. Because it is so easily recognized, this member is the most important key bed in the lower part of the Allegheny group, and definitely determines the identity of the overlying and underlying members.

This limestone does not crop out naturally, which is probably due to its easy solubility and disintegration. It is exposed in pits and drifts opened by the farmers, who burn it for agricultural lime. The Vanport averages about 4 feet thick and appears to be everywhere present under the Lower Kittanning coal in the northern and northwestern part of the quadrangle. It was traced from the Rural Valley quadrangle into the Smicksburg quadrangle along Mahoning Creek to a point about half a mile from the western boundary. From there to Milton, and in the vicinity of Milton, the limestone appears to be absent and the horizon, at some places, is marked by residual iron ore nodules.

At some places in western Pennsylvania, the Vanport limestone has been replaced by the Buhrstone iron ore in the zone of weathering. I. C. White [35] has reported such replacement, or contemporaneous solution and deposition, in Lawrence County. It is not improbable that, where residual iron ore occurs at the horizon of the Vanport in the Mahoning Creek valley about Milton, iron ore may have replaced the limestone in the zone of weathering and that farther under the hill the bed may still be preserved. However, personal communication with some of the natives revealed that efforts to find the limestone in this locality were fruitless; also, south of Milton along the improved road ascending the hill toward Dayton, that part of the section within the range of the Vanport is occupied by shale and sandstone, and a thin coal bed, which is taken to be the Scrubgrass (fig. 38, sec. 174), a coal associated with the limestone in other regions.

The evidence at hand is meager, but it points more in favor of two assumptions: that marine conditions in this area were unfavorable for deposition of calcareous sediments; or, that after they had been deposited, they were removed either by subaerial or subaqueous erosion. Butts,[36] in his studies of the Vanport limestone in the Kittanning quadrangle, takes the view that the thinning or absence of the Vanport is due to the accidents of original deposition, and gives the following summary of the evidence in favor of the assumption that no limestone was deposited in the areas where it is now lacking.

1. The varied character of the Pennsylvanian strata in western Pennsylvania indicates that different kinds of sediments were deposited in different places contemporaneously. The local replacement of the limestone by shale or sandstone is in harmony with the general

[34] Raymond, P. E., Pennsylvania Topog. and Geol. Survey Comm. Report 1908-10, pp. 83, 84, 1911.

[35] White, I. C., Pennsylvania 2d Geol. Surv. Report Q2, pp. 40, 41.

[36] Butts, Charles, U. S. Geol. Survey Geol. Atlas, Kittanning folio (no. 115), p. 7, 1904.

character of the stratigraphy of the region. It is not improbable that conditions were locally unfavorable to the growth of marine organisms from whose shells calcareous sediment of the limestone was derived, or that conditions were unfavorable for the transportation of calcareous sediments from some source more or less removed and their accumulation in the places where the limestone is now absent.

2. The rounded, smooth outline of the areas in which the limestone is wanting resembles the shape of basins of deposition rather than areas of stream erosion or wave cutting.

3. Near the boundary of these areas, the limestone is thinner and more sandy and is soon replaced by sandstone. This would indicate approach to near shore conditions unfavorable for the accumulation and deposition of calcareous material.

4. The limestone is found over large areas as a very thin stratum and it seems improbable that erosion would proceed in these places where it is absent just far enough to remove all but the thin layer of limestone remaining.

Graeber and Foose [37] report the Vanport limestone missing in the northern part of the Brookville quadrangle, and their conclusions are in accord with Butts, that the limestone had not been deposited in the area where it is now lacking.

Following are the details of the graphic sections referred to above:

Diamond drill hole on Smathers farm (fig. 33, sec. 155)

	Ft.	in.
Shale, dark, fissile	26	0
Coal, Lower Kittanning	1	10
Clay	4	4
Shale, sandy	9	6
Clay	1	2
Shale, limy	4	2
Sandstone	6	6
Shale, light, sandy	11	6
Shale, green	13	6
Limestone, Vanport	5	

Diamond drill hole on Blose farm (fig. 33, sec. 157)

	Ft.	in.
Shale, black	12	4
Coal, Lower Kittanning	2	8
Clay	1	5
Shale, gray, sandy	28	7
Shale, dark	7	0
Limestone, interbedded shale, Vanport	7	0
Coal, Scrubgrass	0	1
Shale, sandy		

[37] Graeber and Foose, op. cit., p. 46.

Diamond drill hole south of Punxsutawney (fig. 33, sec. 158)

	Ft.	in.
Shale, black		
Bony coal	0	7
Coal, Lower Kittanning	1	1
Clay, soft	3	2
Clay, hard	5	3
Clay, dark	0	8
Shale, variegated	0	9
Clay, soft	0	8
Clay and limy shale	8	10
Shale, limy	11	0
Shale, light sandy	9	6
Shale, limy	3	6
Limestone, Vanport	3	10
Shale, dark, sandy		

Section southwest of Milton

	Ft.	in.
Shale, dark		
Coal, Lower Kittanning	2	8
Clay and clay shale	3	
Shale, with iron nodules	26	0
Sandstone, (horizon of Vanport limestone?)	9	0
Coal and light plastic clay, Scrubgrass	thin	
Shale, dark	19	0
Coal, Upper Clarion	2	1
Shale and sandy shale	10	0
Shale, carbonaceous, Lower Clarion	0	3
Clay, greenish, sandy	2	5
Shale, gray with siderite concretions and sandstone lenses	7	0
Sandstone, Clarion	35	0

Scrubgrass coal. In the above section southwest of Milton, the coal and underclay of undetermined thickness is 35 feet below the Lower Kittanning coal, or at the approximate horizon of the Vanport limestone. In the section northwest of Hamilton, also shown above, a coal one inch thick lies directly under the Vanport limestone. Those coals are believed to be the equivalent of the Scrubgrass coal and clay, associated with the Vanport limestone in Lawrence County. This coal was observed as a bloom along its outcrop at a few places, but it appears not anywhere to have a workable thickness.

Clarion coals and clay. In some regions of western Pennsylvania, the Clarion coals are thick enough to mine commercially, but in the Smicksburg quadrangle, they are, so far as could be determined, economically unimportant. The Upper Clarion coal appears to be fairly persistent where it crops out in this area. It has an average thickness of about 10 inches, and a maximum observed thickness of 25 inches. The interval below the Vanport limestone ranges from 20 to 35 feet, and is normally filled with dark to black shale, which may be fissile or sandy in part. The coal is underlain by clay and shale containing lenses of sandstone. Siderite concretions up to 12 inches in largest dimension, commonly occur in the strata surrounding the coal. When broken, the interior of some of these iron carbonate concretions is encrusted with small quartz crystals; minute crystals of galena and sphalerite are rarely present.

The Upper Clarion is exposed at the roadside in the village of Milton (Ac11) and is 24 inches thick; southwest from Milton along the improved road on the west side of Mahoning Creek, the same coal crops out in the bluff (Ac19) and measures 25 inches, but is impure. An opening on the Upper Clarion along Nye Branch, south of Timblin, was accessible and revealed 15 inches of coal (Bb10). Good exposures of part of the Clarion section occur at the east and west portals of Mauk tunnel situated in the northern part of the quadrangle, and the Upper Clarion coal is 15 and 12 inches thick, respectively. A drift on the Upper Clarion was opened northeast of Dora (Ca34) and exposed 21 inches of fairly good coal.

The Lower Clarion coal, so far as was observed in this quadrangle, is represented by a band of carbonaceous shale or shaly coal, which lies about 10 feet below the Upper Clarion coal. The Clarion coals and associated beds are shown in the foregoing section at Milton and in the following sections:

Sections at Mauk Tunnel

East portal	*Ft.*	*in.*
Shale, black	20	
Shale, gray, sandy	6	8
Coal, Upper Clarion	1	3
Clay, bluish	7	0
Shale, black	1	3
Clay, bluish, sandy, siderite concretions	9	10
Clay shale	4	

West portal	*Ft.*	*in.*
Shale, gray, sandy	20	0
Coal, Upper Clarion	1	0
Clay, bluish, sandy	8	0
Sandstone	1	0
Shale, gray, siderite concretions	3	6
Sandstone	1	0
Shale, black, fissile	2	6
Clay shale	8	

Section south of New Salem (Aa31)

	Ft.	*in.*
Limestone, Vanport	4	0
Shale, dark to black, siderite concretions	30	0
Coal, Upper Clarion	0	8
Clay shale		

The clays associated with the Clarion coals at some places in western Pennsylvania are excellent fire clays and are being worked on a rather sizable scale. As will be noted in some of the sections above, and in some of the accompanying graphic sections, clay is also associated with these coals at some places in the Smicksburg quadrangle. Although relatively little information on these clays was obtained, their economic value is not promising. Locally, they have a workable thickness and are good quality plastic clays, but within a short distance become impure or are replaced by other materials.

Clarion sandstone. The Clarion sandstone is well developed at most of the places in the quadrangle where the lower part of the Allegheny group is above drainage. It has similar lithologic characteristics to the Homewood sandstone below, and may, therefore, be easily mistaken for that member, particularly where the Homewood is poorly developed. Such an error was made in some of the early reports on the geology of Pennsylvania.

The Clarion sandstone is conspicuous in the northwestern part of the quadrangle from just east of where Sugarcamp Run enters Pine Run and westward along Pine Run into the Rural Valley quadrangle. The top is about 25 feet below the Upper Clarion coal, and the thickness was estimated to be about 40 feet. At the top the sandstone is thin, cross-bedded and medium-grained, becoming heavy-bedded, massive, and coarse-grained downward. The sandstone has a variety of colors, being gray, brown, buff, and pinkish. Carbonized plant remains are present, particularly in the lower part.

The Sprankle Mills anticline has raised the Clarion sandstone high above Mahoning Creek at Milton, where it forms precipitous bluffs and is a prominent feature of the geology. An excellent exposure of this sandstone may be seen southwest of Milton on the west side of Mahoning Creek. It is there gray, medium-grained, cross-bedded and flaggy at the top, and grades downward through heavy to coarse-grained, massive beds, and is about 35 feet thick (fig. 38, see. 174). This sandstone displays its massive character on the road ascending the hill from the creek west of Milton, where it is weathered into huge boulders. Platt,[38] in his report on Armstrong County, was probably misled in this locality by the massive character of the Clarion sandstone and correlated it with the Homewood (Pottsville) sandstone.

Figure 40. Clarion sandstone, southwest of Milton.

The Clarion sandstone is considerably reduced in thickness and is wanting locally in the northern part of the quadrangle on the Sprankle Mills anticline. In the section on the abandoned road west of B.M.1298 (fig. 38, see. 170), the sandstone has thinned to 11 feet, is fine-

[38] Platt, W. G., Pennsylvania 2d Geol. Survey Rept. H5, p. 139, 1880.

grained, light gray, micaceous and thin-bedded. In the sections exposed along the Pittsburgh & Shawmut Railroad, the normal position of the Clarion sandstone is occupied by shale and clay (fig. 38, sec. 171). The Clarion sandstone begins again to assume its massive character just east of where McCracken Run enters Big Run, as was seen by the large boulders in the bed of the stream.

A diamond core drill hole northwest of Hamilton has revealed that the Clarion sandstone is missing, at least locally, and its place is occupied by shale (fig. 38, sec. 173). Just over the eastern border near Punxsutawney, another diamond drill hole shows the Clarion sandstone to have its massive and thick character (fig. 38, sec. 172).

Craigsville coal. In the Kittanning quadrangle, Butts [39] reported a coal 3 feet thick occurring 50 feet below the Vanport limestone at Craigsville and has so named it. This coal is also reported in the Foxburg quadrangle [40] lying 55 to 70 feet below the Vanport limestone and 20 to 30 feet above the Brookville coal.

In the Smicksburg quadrangle along an unnamed run north of Milton (Ab48) a coal was dug having a thickness of 34 inches; the upper 20 inches is a shaly cannel coal. This bed is overlain by dark shale and the floor is clay. The top of the Clarion sandstone is 4 feet below. This coal is about 30 feet below the Upper Clarion coal and about 50 feet below the horizon of the Vanport limestone. Its position with respect to recognizable members in the section appears to correspond to the coal mapped as Craigsville in other regions and it is, therefore, assumed to be that equivalent. The Craigsville is probably local in occurrence as it was not noted elsewhere in the quadrangle.

Brookville coal. The Brookville coal is the basal member of the Allegheny group and separates that group from the underlying Pottsville series. The horizon of this coal is exposed in two small areas in the Smicksburg quadrangle, but the outcrop is mostly concealed. It may, however, be a fairly persistent bed as its presence was indicated in the diamond drill holes that piereed the horizon, and coal is indicated at its position in the section in numerous wells drilled for natural gas (see table 5). The Brookville ranges from about 70 to 110 feet below the Vanport limestone, is usually overlain by dark shale, and may occur as a split bed. This coal has been mined commercially at some places in western Pennsylvania, but little information was obtainable on it in this quadrangle. Its present commercial possibilities are doubtful.

Elevated by the Sprankle Mills anticline in the northern part of the quadrangle, the Brookville horizon is exposed about 2 miles up Big Run and extends up some of the tributaries. On the axis of the anticline the outcrop is about 160 feet above the run. Several openings had been made on the bed in this locality and it had been worked for house coal. West of the Pittsburgh & Shawmut Railroad, the coal was exposed in the run (Da13) and occurs as a split bed separated

[39] Butts, Charles, Kittanning and Rural Valley quadrangles, U. S. G. S. Bull. 279, p. 32, 1906.

[40] Shaw, Lines and Munn, U. S. Geol. Survey Geol. Atlas, Foxburg-Clarion folio (no. 178), p. 47, 1911.

by 19 inches of shale. The upper bench is 42 inches thick and is fairly good coal. The lower bench is 17 inches thick. South of that place, there is a caved bank on the Smith farm (Da21) where the Brookville was reported to occur in two benches 41 and 18 inches thick. The Brookville coal was reported to have been opened and to be 48 inches thick on the hill east of the Pittsburgh & Shawmut Railroad. The outcrop of the Brookville is exposed in a gully on an abandoned road near the northern boundary of the quadrangle (Da3) where it is a single bed 24 inches thick, impure and overlain by dark shale.

The Brookville horizon is below drainage in the valley of Pine Run in the northwestern part of the quadrangle, but at Charleston, which is just over the border in the Rural Valley quadrangle, the coal is in the bed of the run and measures 2 feet. Farther down stream near the bridge, the coal is above the run and had been worked for house coal. It was reported to occur in two benches, the upper 24 and the lower 18 inches thick, separated by 6 feet of shale. Still farther down the stream in a cut made to elevate the tracks of the Pittsburgh & Shawmut Railroad above the Mahoning dam reservoir, the Brookville coals and associated beds are well exposed and the following section was obtained.

Section southwest of Charleston

	Ft.	*in.*		*Ft.*	*in.*
Sandstone, Clarion	40	0	Clay shale	1	11
Shale, dark	3	0	Clay shale, sandy	1	1
Shale, carbonaceous	0	8	Shale, black	0	2
Coal, Brookville upper bench	0	3	Coal, Brookville lower bench	1	0
Clay shale	0	8	Bony, do.	0	2
Bony coal	0	2	Coal, do.	0	11
Clay shale	0	5	Shale, black	0	8
Sandstone	3	8	Shale, gray, sandy	6	
Shale, carbonaceous	0	6			

Brought up by the Sprankle Mills anticline, the Brookville crops out in the steep-sided valley of Mahoning Creek northwest of Milton, and where the axis of the anticline crosses, the horizon of the Brookville is about 250 feet above the stream. The slopes are covered with vegetation and rock debris and the outcropping rocks are mostly concealed.

Southwest of Milton (Ac18), the Brookville coal appears in the bed of the creek and is 20 inches thick. In the bluff on the east side of the creek at Milton (Ac12), the coal is also 20 inches thick and had been dug by the natives. The section at this place is not well exposed, but the coal is overlain by dark shale. About 10 feet of gray, fine- to medium-grained, platy and cross-bedded sandstone appears below the coal, which in turn is underlain by 15 feet of dark shale, then the top of the Homewood sandstone. The coal at this place probably is the upper bench of the Brookville. The lower bench is either wanting or has been replaced by the sandstone that here underlies the coal, because on the opposite side of the creek along the road that ascends the hill (Ae13), the two benches of the Brookville appear as blooms separated by about 10 feet of dark shale.

POTTSVILLE SERIES

General Description

The top of the Pottsville series is drawn at the base of the clay underlying the Brookville coal. The bottom lies unconformably on the Burgoon sandstone member of the Pocono since it has been definitely established that the Mauch Chunk, if deposited, has been eroded from this region.

The entire thickness of this series of rocks undoubtedly occurs in the gorge of Mahoning Creek northwest of Milton, but is, unfortunately, concealed by vegetation and by debris from massive sandstones. Practically all the wells drilled for natural gas in the quadrangle have penetrated the Pottsville series, but the records do not show enough detail to determine the disconformity, and samples of well cuttings are not available. Therefore, the thickness of the series in this quadrangle is not known. In the Brookville quadrangle, to the north, Graeber and Foose [41] report the Pottsville to be about 200 feet thick and consisting of the Homewood sandstone in the upper part, averaging 40 feet thick; the Mercer clays and shales in the middle, averaging 30 feet thick; and the Connoquenessing sandstone in the lower part, at least 90 feet thick. The approximate thickness of the Pottsville series in the Clarion quadrangle is 120-130 feet, along Allegheny River 125-200 feet, in the Punxsutawney quadrangle 200 feet, and in the Rural Valley quadrangle 140 feet.

Farther west in Pennsylvania, the Connoquenessing sandstone is divided into two parts separated by the Quakertown coal and shales; the Sharon coal and shales underlie the lower division.

The Lykens Valley coals of the anthracite fields of Pennsylvania, the Kanawha, New River, and Pocahantas fields of West Virginia and the coals of Virginia, Tennessee, Georgia, and Alabama occur in the Pottsville series.

Homewood sandstone. About 10 feet of the Homewood sandstone is exposed in Mahoning Creek at Milton, where it made a natural abutment for the covered wooden bridge. The top few feet of the sandstone is medium-grained and cross-bedded, becoming massive and coarse-grained with scattered quartz pebbles downward. It is generally gray, but is iron-stained in part. The fractures are filled with limonite, which protrudes on the weathered surface; plant impressions were also noted.

The Homewood crops out in the area about Big Run on the Sprankle Mills anticline, and its character differs somewhat from its occurrence at Milton. The top of the sandstone is about 25 feet below the Brookville coal, which space is filled with generally dark to black shale. A good exposure of the Homewood occurs on the road just north of B.M.1333. It is there 24 feet thick, medium-grained, gray, cross-bedded, platy to flaggy at the top, and heavier bedded toward the base. Weathered-out specimens of *Stigmaria ficoides,* replaced by sandy material, were also observed. About one mile northwest of the above locality, the Homewood sandstone is thinner and has a different

[41] Graeber, C. K., and Foose, R. M., op. cit., pp. 55-63.

character, as was observed of its outcrop on the abandoned road west of B.M.1298, where it is 5 feet thick, grayish-white, medium-grained and micaceous.

Mercer member. As indicated in the reports on the geology of western Pennsylvania, the Mercer usually occurs as a composite member of the Pottsville series, containing coal, clay, and shale. The name was originally applied by White [42] to the beds occurring in the interval between the base of the Homewood and the top of the Connoquenessing sandstones near Mercer. In some areas of western Pennsylvania, the Mercer member contains coal and clay that have economic value. The clay is particularly important in Clearfield and Clinton Counties, where for many years it has undergone extensive commercial development, and thus constitutes one of the State's sources of mineral wealth. Recent investigations of the Mercer clay in Clearfield, Clinton and several adjoining counties by the Pennsylvania Geological Survey have revealed considerable tonnage of nodular-type diaspore clays. These high-alumina [43] clays are an

[42] White, I. C., Geology of Lawrence County: Pa. Second Geol. Survey Rept. Q2, pp. 57-62, 1879.

[43] Foose, R. M., High alumina clays of Pennsylvania. Economic Geology, vol. xxxix, no. 8, pp. 557-577, 1944.

Figure 41. Top of Homewood sandstone in Mahoning Creek at Milton.

excellent raw material for the manufacture of refractory and super-refractory products, and are also potential sources of aluminum.

In the Smicksburg quadrangle, the Mercer horizon doubtless is well above drainage on Mahoning Creek northwest of Milton, but as stated earlier, the outcropping rocks are mostly concealed. The Mercer is also above drainage on the Sprankle Mills anticline in the Big Run area. Two partially exposed outcrops were observed in this area.

In the section north of B.M.1333 (fig. 38, sec. 171), the interval from the base of the Homewood sandstone to the top of the Connoquenessing sandstone is about 10 feet. The material occupying that interval is somewhat weathered, but immediately under the Homewood there are a few inches of coaly shale, under which is exposed about 5 feet of what appears to be a dark, argillaceous sandstone, or dark sandy clay. About one mile to the northwest, in the section west of B.M.1298 (fig. 38, sec. 170), the 5 feet of Homewood is underlain by about 20 feet of shale, at the base of which is weathered plastic clay of undetermined thickness occurring about 8 feet above the top of the Connoquenessing sandstone.

Figure 42. Mahoning Creek looking northwest from Milton, showing boulders from lower Allegheny, Pottsville and Mississippian sandstones.

In geologic nomenclature, some names of rock units imply a specific lithologic character. In this connection, the name Homewood is restricted to a sandstone at the top of the Pottsville series. However, it is not uncommon that material other than sandstone occupies the place of the Homewood. Comparing the above sections, it appears that the shale underlying the 5 feet of Homewood in section 170 had been deposited contemporaneously with the sandstone occupying the corresponding part of section 171. Should this have been the true depositional history, the shale under the Homewood sandstone in section 170 would also be Homewood in age. However, because the Mercer member is largely shale, the shale in section 170 would prob-

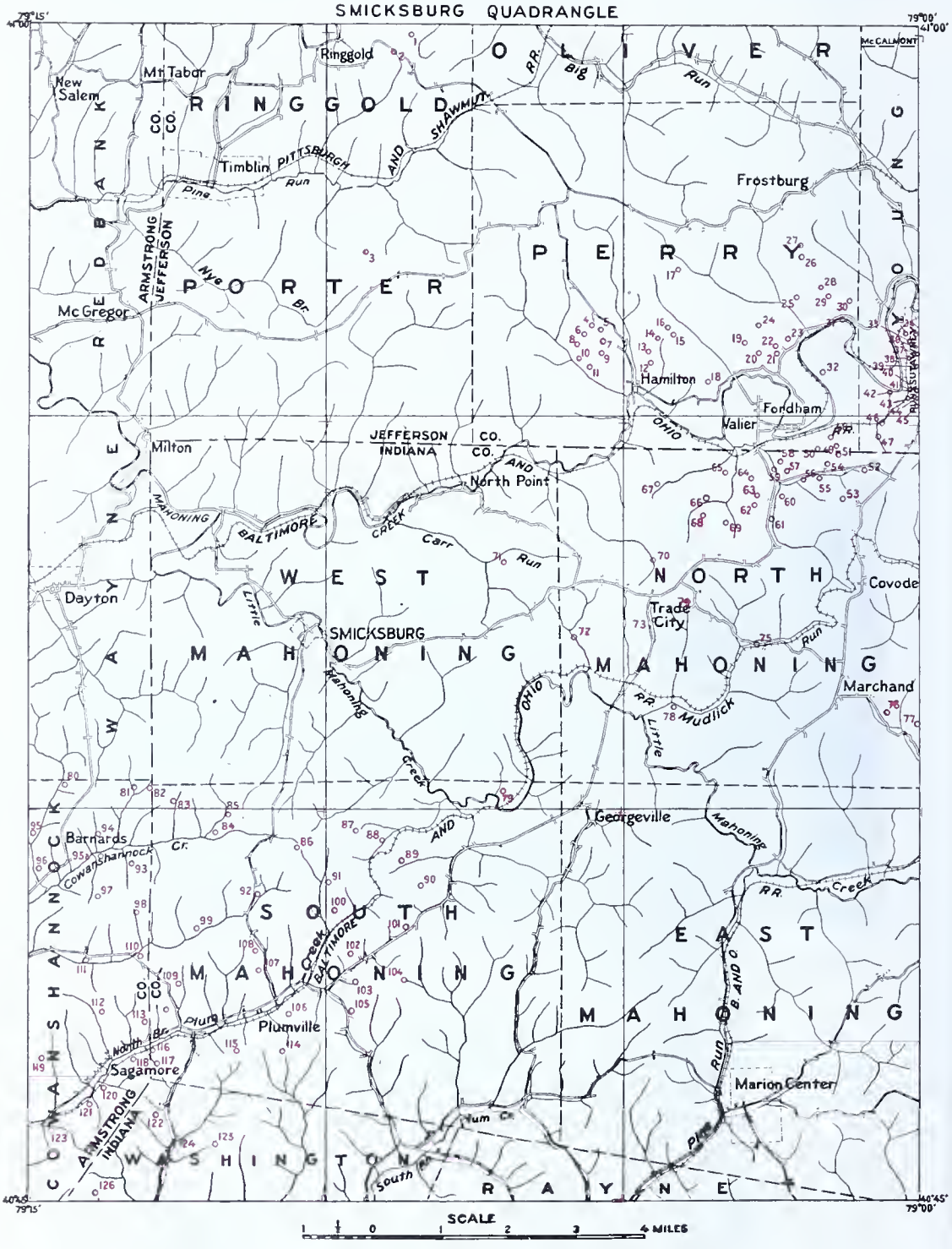


Figure 43. Map showing the location of diamond core drill holes.

ably be called Mercer. This raises the question: Where is the shale in section 171? Has it been eroded, and the Homewood deposited in its place, or is the thick sandstone actually Mercer? These are questions that must inevitably face any stratigrapher in studying the Pottsville-Allegheny section. Field evidence in this area has not been sufficiently diagnostic to answer them. For instance, it cannot be demonstrated at any place that the so-called "Homewood" sandstone occupies an eroded part of the Mercer, even though it seems apparent that this may be locally the case. Likewise, it cannot be demonstrated that the Homewood sandstone, or shales that definitely occupy the position of the Homewood sandstone, are not an extended Mercer section.

Coal is indicated in some of the gas well records (see table 5), ranging from 400 to 465 feet, and averaging 430 feet below the horizon of the Upper Freeport coal. This roughly corresponds to the computed Upper Freeport-Mercer interval of about 420 feet in the Big Run area. The indicated thickness of the coal ranges from 2 to 6 feet.

Connoquenessing sandstone. Below what is considered to be the Mercer member in the Big Run area, occurs a light-gray to whitish, medium-grained sandstone, which is flaggy, cross-bedded, massive and friable in part; muscovite specks and pinkish stains were also noted. This sandstone is taken to be the Connoquenessing. Its appearance is similar to the description of that member in the Brookville quadrangle,[44] where it is reported to be up to 90 feet thick.

The Connoquenessing is conspicuous in the valley of Big Run northwestward from near B.M.1358. The top of this sandstone is about 80 feet above the stream where the axis of the anticline crosses. The lower part of the section in the valley is concealed, but the thickness of the sandstone is at least 60 feet.

All of the Connoquenessing is above Mahoning Creek northwest of Milton. Although it was not found in place, huge detached sandstone blocks of comparable lithology revealed the approximate position of the horizon. The largest observed dimension of these blocks is about 20 feet; this, however, is not taken to represent the thickness of the sandstone, as it is thought to be considerably thicker. Some of these blocks have drifted down the valley sides to the creek level and are resting probably on the Pocono sandstone.

MISSISSIPPIAN SYSTEM

In southwestern Pennsylvania, the Mississippian System is composed of the Mauch Chunk red shales and sandstones at the top, which includes the Greenbriar limestone; the Loyalhanna siliceous limestone in the middle, and the Pocono sandstones and shales at the bottom. If 150 feet is assumed to be the thickness of the Pottsville in the northwestern part of the Smicksburg quadrangle, approximately 100 feet of rocks of the Mississippian System are above Mahoning Creek northwest of Milton.

Mauch Chunk series. In the eastern part of Pennsylvania, the Mauch Chunk series has a thickness of several thousand feet, and

[44] Graeber, C. K., and Foose, R. M., op. cit., p. 63.

consists of red shales with interbedded sandstones. Studies of this series in western Pennsylvania have revealed that it thins from east to west, and in some regions it is doubtful if it ever was deposited. After deposition of the Maueh Chunk, central Pennsylvania was raised above sea level and part or all of these strata, and in some plaees some of the underlying rocks, were eroded, hence the sediments of Pottsville time were deposited uneonformably on an eroded surfaee. Butts[45] in the Rural Valley quadrangle, and Graeber and Foose[46] in the Brookville quadrangle, have determined that the Maueh Chunk (if deposited) and the upper part of the Poeono have been removed by erosion and that the Pottsville lies uneonformably on the Burgoon sandstone member of the Poeono.

A seareh on the bluffs along Mahoning Creek northwest of Milton failed to reveal any evidenee of the presenee of the Mauch Chunk. Also, the reeords of wells drilled for natural gas in this area and elsewhere in the quadrangle do not indieate red beds at the expeeted position of the Mauch Chunk, but rather a predominanee of sandstone. Based on this negative evidence, and the faet that the Mauch Chunk is reported as missing in the Brookville and Rural Valley quadrangle, it would, therefore, seem reasonable to eonelude that the Maueh Chunk probably is missing in the Smieksburg quadrangle.

Burgoon sandstone. On the north side of Mahoning Creek near where it leaves the Smieksburg quadrangle, there is a sandstone eliff about 40 feet high, the base of whieh is about 15 feet above the ereek level. The lateral extent of the exposure is about 200 feet. This sandstone is generally massive to flaggy, eross-bedded, gray to tan and medium- to fine-grained. The top of the outerop is about 190 feet below the horizon of the Brookville eoal. Assuming that the Pottsville is about 150 feet thiek, and that the Maueh Chunk is absent, this sandstone would be part of the Burgoon member of the Pocono series. These are the oldest roeks exposed in the quadrangle. They are nonmarine in origin. The Burgoon is the Mountain or Big Injun "sand" of the well drillers.

UNEXPOSED ROCKS

Source of information. Information about the unexposed or subsurface rocks in this region is derived entirely from the reeords of wells drilled for natural gas. The reliability of these reeords is questionable because the drillers are generally not trained to interpret the lithology from a geologie standpoint. They only easually examine the cuttings brought up by the bailer, and eommonly log the wells by the relative ease the bit euts the roeks, or by the polishing effeet the roeks have on the bit. The reeords are also ineomplete beeause the drillers are ehiefly eoneerned with the "sands," and in partieular the expeeted produeing sand; therefore, they usually overlook or disregard beds that would have geologie value as key horizons and whieh would be useful in a better eorrelation of the strata. The thiekness of the beds and the depth from the surfaee are usually determined by

[45] Butts, Charles, op. cit., Bull. 279, p. 24, 1906.
[46] Graeber, C. K., and Foose, R. M., op. cit., p. 63, 1942.

the length of cable used. This method is likely to be inexact, which is further increased by cable stretch. In later years, many of the larger companies, realizing the value of geologic data, insist on more accurate recordings, and measurements, and important horizons are checked by a steel line. A more accurate method of logging a well is by examination of a complete set of samples by a geologist. Unfortunately, a complete set of samples from any of the wells in the Smicksburg quadrangle was not available.

Some of the records appear to be fairly good and give a general idea of the nature of the subsurface rocks. The sections shown on plate 5 (see also figs. 87-95) were plotted from selected records of wells in various parts of the quadrangle that appear to be more complete and wherein the approximate position of the horizon of the Vanport limestone could be determined. The blank intervals in the sections are assumed to be filled with shale or sandy shale, which is logged by the drillers as "slate" or "slate and shells."

The skeleton log of F. C. Deemer's W. H. Irwin Company's tract Well No. 1 in Gaskill Township, Jefferson County, was included for comparison. The formational boundaries of this record were determined by Fettke[47] from his study of the well cuttings.

Rocks Penetrated

The subsurface or unexposed rocks penetrated in drilling for natural gas in the Smicksburg quadrangle belong to the Pocono series of the Mississippian system; and the Catskill, Chemung and Portage facies of the upper Devonian system.

Pocono series. The Pocono series at the Allegheny Front was reported by Butts and Moore[48] to be about 1,000 feet thick. Fettke indicated a thickness for the Pocono of 900 feet in the log of the Irwin well, and places the bottom at the top of the first red bed of the Catskill facies. The Pocono series has been subdivided in some detail in northwestern Pennsylvania, but the subdivisions have not been carried progressively into this area; and a subdivision of the Pocono in this area would be practically impossible from the data available.

Taking an arbitrary interval of 250 feet from the Vanport limestone to the base of the Pottsville series, and accepting the base of the Pocono where Fettke places it in the Irwin well log, the average thickness of the Pocono series in the sections shown on plate 5 would be about 945 feet. The upper 250 feet as indicated on the well logs is predominantly sandstone and many logs show continuous sandstone for the entire interval. This sandstone probably corresponds to the Burgoon and is the Mountain or Big Injun sand of the drillers. Below the Burgoon comes an interval of about 300 feet of alternating shales and sandstones. Many logs show one or more beds of "red rock" ranging from about 30 to a little over 100 feet in thickness.

[47] Fettke, Chas. R., Subsurface sections across western Pennsylvania; Pa. Geol. Surv. Progress Report 127, p. 33, 1941.

[48] Butts and Moore, The geology and mineral resources of the Bellefonte quadrangle, Pa.: U. S. Geol. Survey Bull. 855, p. 75, 1936.

They apparently do not occupy a definite position in the section. These rocks are within the approximate limits of the Patton formation. The drillers log the sandstones as the Squaw, First Gas, and Second Gas sands.

The lower 400 feet of the Pocono is composed of sandstones with intervening shales, and probably includes the equivalents of the Shenango, Cuyahoga, Berea, and Cussewago formations of northwestern Pennsylvania. The upper 250 feet of this interval is dominantly sandstone and the lower 150 feet is mostly shales. The sandstones vary in thickness and number of beds and have been designated by the drillers as the Berea, Murrysville, Hundred-foot, Thirty-foot, Boulder, and Snee sands.

Catskill facies. Based on Fettke's interpretation of the log of the Irwin well, the Catskill facies is the top of the Devonian series and he indicates a thickness of 486 feet for the facies. At the Allegheny Front, the thickness is given as from 1,200 to 1,600 feet.[49] In northwestern Pennsylvania, the Catskill is divided into the Riceville and Venango groups and contains the Venango oil sands.[50] In the Smicksburg quadrangle, the red beds of the Catskill range from about 250 to 350 feet thick. Because they are so easily recognized, they are the main marker for the gas well drillers. Examination of some well cuttings from the Catskill indicates a series of red and greenish-shales and sandstones. The sandstones are relatively thinner and are medium- to fine-grained. Occasional layers of siltstone also are present. In this section the drillers log the Gordon Stray, Gordon, Bayard, and Bayard Stray sands.

Chemung and Portage facies. The thickness of the Chemung and Portage facies as determined by Fettke in the Irwin well is 5,002 feet, and the top of the combined facies is placed at the bottom of the lowest red bed of the Catskill. The total thickness of these rocks in the Smicksburg quadrangle probably is close to the thickness given for the Irwin well. The T. W. Phillips Gas and Oil Company's Lighteap well in southwest East Mahoning Township (see pl. 5), started at an elevation of 1,390 feet (190 feet above the Upper Freeport coal horizon; 450 feet above the Vanport limestone horizon) and was drilled to a total depth of 7,002 feet. Comparing the record of this well with that of the Irwin well, it appears that the Lighteap well was finished just above the Tully limestone horizon and penetrated approximately 5,040 feet of Chemung and Portage rocks.

The well logs in the Smicksburg quadrangle show a predominantly shaly interval with a few lenses of sandstone from the base of the Catskill red beds down to an average depth of 500 feet. Some of the records indicate "pink rock" with a maximum thickness of 350 feet. Some logs indicate a red bed having an average thickness of 40 feet and occurring at a fairly regular depth of 400 feet below the average base of the Catskill. Fragments of shells were noted in well cuttings and occur at various positions. The sandstones in this

[49] Butts and Moore, op. cit., p. 73.

[50] Dickey, Sherrill, and Matteson, Oil and gas geology of the Oil City quadrangle: Pa. Geol. Surv. Bull. M25, pp. 23-40, 1943.

interval have been named by the drillers the Elizabeth, Elizabeth Stray, First, Second, Third, Fourth, and Fifth Warren sands.

Below the shaly interval the sandstones are more numerous, are thicker, and extend down to about 2,000 feet below the average base of the red rock. These are the lowest gas-producing sands in this region and are called by the drillers the Speechley Stray Stray, Speechley Stray, Speechley, Tiona, First and Second Balltown, Sheffield, First, Second, and Third Bradford, First, Second, and Third Kane, and First, Second, and Third Elk sands.

STRUCTURE

Definition

Geologic structure is that part of the geology of a region which pertains to the attitude or position of the rocks with relation to the horizontal, and the nature and amount, if any, of the deformation which they may have undergone. In western Pennsylvania the rocks were originally deposited as sediments in an inland sea in approximately horizontal layers. Since their deposition and solidification, they have been subjected to great pressure, apparently from the southeast, which pushed the rocks into low folds or rolls trending northeast-southwest. In this region, the folds are very gentle; toward the northwestern part of the State they gradually die out and the structure becomes warped. East of the Allegheny Front the folding was more intense and the rocks have been fractured, faulted, overturned, and overthrust and the structure is very complex.

The angle between the inclination of the bedding plane and the horizontal is called the dip of the bed. The direction of the line of intersection between the bedding plane and the horizontal is called the strike. A fold in which the rocks dip away from the axis and form an arch is called an anticline. Where they dip toward an axis and form a trough, the fold is called a syncline. The line following the highest part of an anticline and the lowest part of a syncline is called the axis. These axes are not horizontal, but rise higher and sink lower in some areas than in others, and give a plunging character to the structure, forming domes and saddles. The axes do not form straight lines, but rather tend to be sinuous; they are roughly parallel. Where the dip of the rocks is in one direction in a limited area, it is called a monocline. The term monocline may refer to a downward flexure of the rocks from one level to another.

Uses of Geologic Structure

A geologist mapping an area first determines the trend of the structure; this is essential to the correct correlation of the beds from place to place.

A structure map of a region offers important data to mining projects and to the prospector for oil and gas. Mines may be so located as to take advantage of the dip of the bed to give natural drainage and down-grade for haulage of loaded cars. The importance of this knowledge is shown by the mines that were abandoned because the

coal dipped away from the outcrop. The relation that structure bears to the production of oil and gas will be discussed farther on in this report.

With a geologic structure map, a farmer or prospector may at any given point determine approximately the vertical distance to an underlying or overlying coal or limestone bed. This is accomplished by adding to or subtracting from the elevation of the reference bed upon which the structure contours are based, the average interval between the two strata.

Methods of Representing Structure

The method employed to represent the geologic structure of a region depends upon the nature of the structure of that region. Where the rocks are steeply folded and faulted, as in eastern Pennsylvania, the structure is represented by the dip and strike method, which consists of the use of symbols indicating the direction of the strike and the direction and amount of the dip at a particular locality; or by drawing a series of cross sections. In western Pennsylvania where the angle of dip is low and there is only minor or no faulting, the cross section could be used, but this would necessitate the construction of an impractical number of sections to show adequately the structural features. The best method, and the one commonly employed to represent detailed structure in this part of the State, is the use of structure contours similar to those representing the topography.

In this quadrangle and in all adjacent quadrangles, the structure contour method was used. It consists of first selecting a suitable reference stratum or key bed having extensive outcrop and which could be easily recognized in the field. Considering the Smicksburg quadrangle on the whole, the Upper Freeport coal appeared to be the logical bed upon which to base the structure contours. This bed was also used as a structure datum for the Punxsutawney quadrangle to the east and for the Indiana quadrangle to the south. Elevations above mean sea level were determined on this bed at outcrop, from mine surveys, and diamond drill holes where the elevation of the top of the hole was known, or on a recognizable bed above or below, and the elevation of the Upper Freeport coal was calculated by subtracting from the bed above, and by adding to the bed below, the nearest known vertical distance between these two strata. Many such points were determined, plotted on the topographic map at their exact locations, and lines drawn through points having equal elevations; for example, the selected contour interval or distance between lines is 25 feet, then lines were drawn say at 1,200, 1,225, and 1,250 feet, and show that the Upper Freeport coal is 25 feet vertically higher or lower than the next line. The intersection of a surface contour line with a structure contour line of the same elevation, indicates a point above sea level of outcrop of the Upper Freeport coal, and each one of these lines is coincident with a line which may be traced along the top of a bed.

It follows then that these structure contour lines not only show the position of the Upper Freeport coal in relation to the topography,

but the approximate position of other valuable beds might be located in any part of the quadrangle by consulting the stratigraphic section for the interval between the Upper Freeport coal and the bed sought. For example, a coal operator desires to know the depth of the Lower Kittanning coal at Porter. The elevation of the road intersection at that place is shown on the topographic map to be 1,572 feet; referring to the structure contour map, it will be noted that that point lies between the 1,550- and 1,757-foot structure contour lines, or interpolated, would be 1,565 feet. The Upper Freeport coal would then lie 7 feet below the surface at that point. The stratigraphic column shows that the interval between the Upper Freeport and the Lower Kittanning coal is 200 feet. Therefore, the Lower Kittanning coal at the road intersection at Porter would be about 207 feet below the surface.

Accuracy of Structure Contours

Three factors are involved in the accuracy of the structure contours: first, the accuracy of the elevations determined directly; second, the variability of the calculated intervals between key beds; and, third, the number and distribution of the points where elevations were obtained. All observations were based on bench marks on the topographic map. These bench marks are not too well distributed, and in many cases elevations had to be carried long distances by aneroid barometer, and set at road intersections where they were lacking. These elevations were, however, checked from two or more points and probably are correct to within 5 feet. Most elevations on mines and outcrops were obtained with the Locke hand level and the error is not over three feet. Where it was difficult or impractical to hand level to a coal or limestone opening a considerable distance from a bench mark or in thick woods, the elevation was obtained by the barometer and carefully checked. This method is liable to more or less error but elevations are believed to be within 10 feet.

As was earlier discussed under Stratigraphy, the beds above and below the Upper Freeport coal are subject to considerable variation in interval. In most of the quadrangle the error for this factor was kept at a minimum by frequent checks of those intervals on the surface and by sections of diamond drill holes. This is particularly true where rocks of the Allegheny group are exposed, but where beds in the Conemaugh had to be depended upon for structural control, as in the upland east and west of Smicksburg, in the vicinity of Covode and Marchand, and between North Branch Plum Creek and Pine Run, the error is likely to increase. Notwithstanding these possible sources of error, it is believed that the structure as mapped is within a contour interval of being correct at any and all points in the quadrangle.

Earlier Mapping of Structure

In the reports of the Second Pennsylvania Geological Survey covering Armstrong, Indiana, and Jefferson Counties, Platt described numerous anticlines and synclines running in straight lines and in

parallel order, trending approximately N. 35° E. Comparing the earlier mapping with the recent detailed mapping shows that the structural axes, instead of being straight, parallel lines, are actually only roughly parallel and very sinuous; also, that the axial lines as formerly drawn are considerably in error.

There is some discordance in matching the detailed structure in the adjoining quadrangles with that of this quadrangle, although it is essentially similar. Excepting the Brookville on the north, the field work of which was completed in 1935, and with which the structure in the Smicksburg quadrangle matches fairly well, those quadrangles were completed long before field work in this quadrangle was started, and done by different geologists and at different times. The main reason for this discordance of structure is probably lack of information which was available when this quadrangle was surveyed, such as later mining operations, exposures made by cuts for road construction, and the results of diamond core drilling.

Detailed Structure

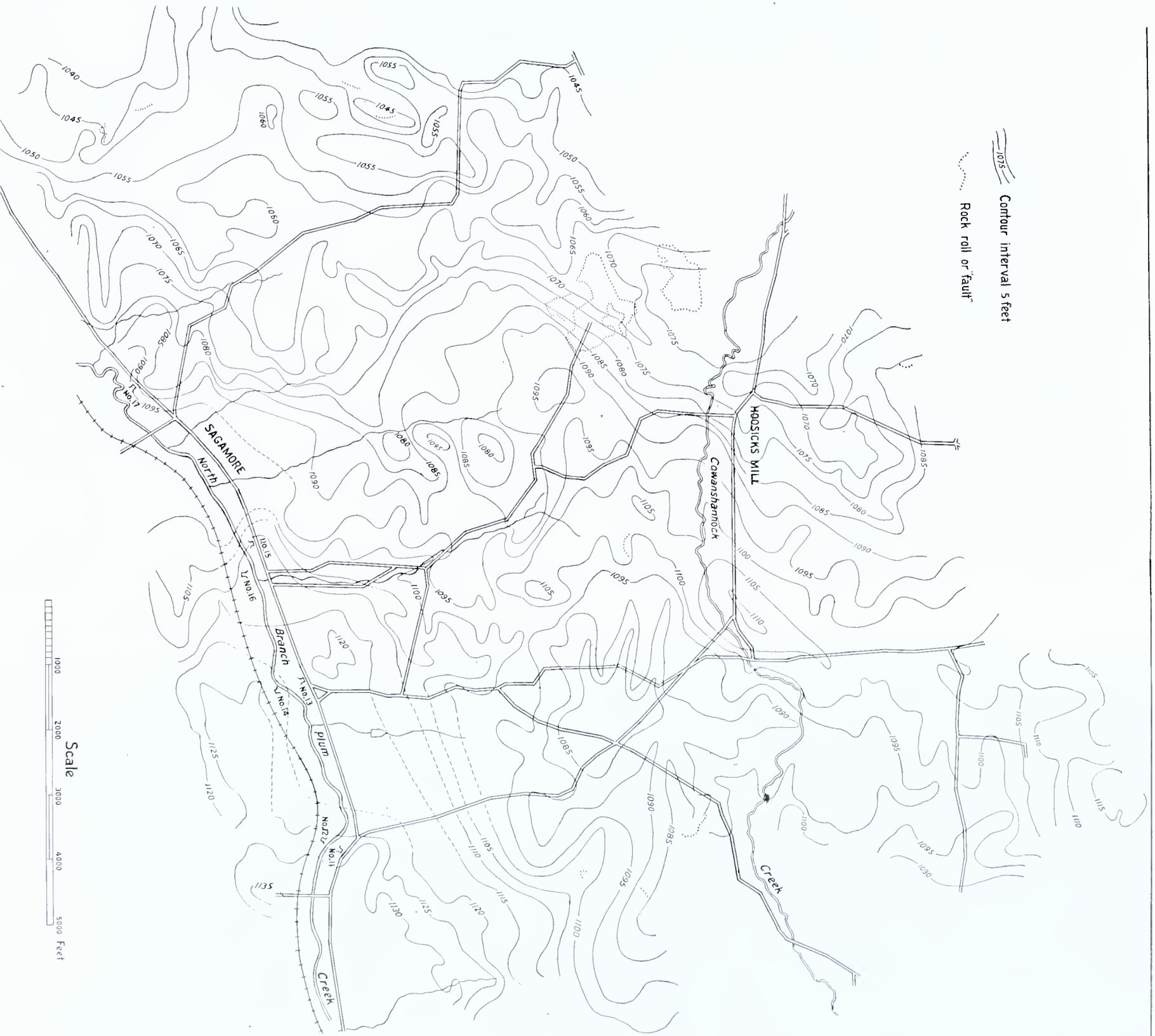
The Smicksburg quadrangle lies in the region of generally northeast-southwest trending folds, forming arches and troughs, which, for descriptive purposes, are called anticlines and synclines. Viewed regionally, these structures have a regular and parallel appearance. Close examination has revealed, however, that in detail they are very irregular, only roughly parallel, and tend more to be asymmetrical. The general trend of the axes is approximately N. 50° E., but varies locally from nearly north-south to nearly east-west. They rise and fall in a series of "highs" and "lows" or domes and saddles. The dip of the flanks varies from nearly flat to over 400 feet per mile. Generally the flanks are mildly irregular, but relatively sharp spurs and reëntrants occur at some places.

The rolling nature of the coals and associated clays, as was revealed in mine surveys and coal stripping operations, is a minor structural feature (drag folds) that is confined to the coals and underclays and not reflected in the overlying and underlying beds. This is essentially a feature of structural adjustment and results from the relative incompetency of coal and underclay, which yield more readily to regional stress tending to deform the strata. Such irregularities are frequently strong enough to create a reversal of dip on a rather steeply dipping limb of a major structure. Therefore, an observation on an isolated coal outcrop where the enclosing strata are concealed could be misleading.

There are four anticlines and three synclines in the Smicksburg quadrangle. They are from northwest to southeast as follows: North Freedom anticline, Worthville syncline, Sprankle Mills anticline, Punxsutawney syncline, Plumville anticline, Elders Ridge syncline, and Richmond anticline (pl. III).

North Freedom anticline. The North Freedom anticline was named for that place in the Brookville quadrangle, and is the most prominent upfold in that area. Platt called it the Brookville anticline and connected it with the anticline west of Brookville. Graeber

PLATE 6. DETAILED STRUCTURE ON THE TOP OF THE UPPER FREEPORT COAL IN MINES OF THE BUFFALO & SUSQUEHANNA COAL & COKE CO.



and Foose,[51] however, have shown that this is incorrect. The southwestern end of the North Freedom anticline is in the northwestern corner of the Smicksburg quadrangle. The axis enters the quadrangle north of New Salem along Mudlick Creek, and plunges at about 50 feet per mile, terminating just north of Pine Run. Mapping in the Rural Valley quadrangle shows the axis of this fold continuing for a short distance into that quadrangle. The structure in that area is based on the Vanport limestone, which probably accounts for that discrepancy. The control for this anticline in the Smicksburg quadrangle is based on the Vanport limestone, Lower Kittanning, Lower Freeport, and Upper Freeport coals.

Worthville syncline. The Worthville syncline in this quadrangle is the southwestern end of a pronounced structure in the Brookville quadrangle and is named after Worthville, a small village in the southern part near which the axis passes. The axis enters the Smicksburg quadrangle north of Ringgold, trends southwestward, passes west of Timblin, and rises about 35 feet per mile. At Pine Run it turns sharply westward, follows the run and enters the Rural Valley quadrangle, where it shortly dies out. The southeast limb rises from the center of the basin about 100 feet per mile; the northwest limb rises about 50 feet per mile. Control for this fold is based on observations on the Vanport limestone, Lower Kittanning and Upper Freeport coals. The axis as drawn at the northern border of the quadrangle is slightly to the east of where it is drawn in the Brookville quadrangle. This structure conforms somewhat with what Platt mapped as the Leechburg syncline.

Sprankle Mills anticline. The Sprankle Mills anticline was named for a village situated along Big Run at the southern border of the Brookville quadrangle. It is the most prominent structure in the Smicksburg quadrangle, extends about 9½ miles across the northwestern part, and has a maximum relief of over 630 feet in this area. This anticline has raised up all of the Allegheny and part of the Pottsville in the Big Run area at the north, and the Allegheny, the Pottsville, and the upper part of the Pocono in Mahoning Creek northwest of Milton. Numerous observations on recognizable members of the Allegheny group on the surface and a few mine surveys control this structure. Mapping in the Big Run area was done by plane table.

The axis enters the Smicksburg quadrangle just east of where Big Run enters the Brookville quadrangle. It has a fairly regular southwest trend, which is interrupted by two pronounced flexures; one of these occurs northwest of Grange, the other north of Porter. The axis plunges from a "high" in the Brookville quadrangle, crosses a slight rise at the headwaters of Pine Run, thence continues to plunge from about 25 feet to about 50 feet per mile to Nye Branch. From there it rises slightly to an elongated "high" with the axis passing south of McGregor and leaving the quadrangle just south of 40° 55′ parallel. This anticline continues in the Rural Valley quad-

[51] Graeber and Foose, op. cit., p. 72.

rangle, where it also is a prominent fold and is called the Greendale antieline.

The northwest flank of the Sprankle Mills antieline east and southeast of Ringgold is fairly regular, and has an almost uniform dip of about 150 feet per mile. Southwestward the dip is less uniform and averages less than 100 feet per mile. Also, the flank is interrupted by a spur and reëntrant north of McGregor. The horizontal distance from the axis of the Worthville syneline to the axis of this antieline varies from about 2 miles at the west to nearly 3 miles at the north. The southeast flank is broader, loeally steeper, and relatively irregular. The horizontal distanee to the axis of the Punxsutawney syneline varies from a little less than six miles at the southwest to a little over seven miles at the northeast. From the axis northwest of Grange, to the 1,550-foot contour south of Frostburg, the dip varies from about 25 to 125 feet per mile. From there it is very steep, falling at a maximum rate of approximately 400 feet per mile. Southwestward the dip becomes morc gentle and uniform, averaging about 75 feet per mile to near Milton, where it again steepens to about 400 feet per mile. This antielinal limb is eharacterized by numerous irregularities, some of whieh have developed into spurs and reëntrants sueh as are indieated by the sharp folds in the area about Loop and Smicksburg.

Punxsutawney syncline. The Punxsutawney syncline was named for that plaee in the Punxsutawney quadrangle through which the axis passes. This strueture enters the Smicksburg quadrangle as a fairly well developed trough that is interrupted north of Trade City. The strength of this syncline decreases southwestward; and west of Little Mahoning Creek it beeomes a broad, gently dipping fold that terminates as a warped structure. The axis has a general southwest trend, with gently eurving flexures, some of whieh bear nearly due west and south. It enters the Smieksburg quadrangle northeast of Sportsburg and rises about 25 feet per mile to just beyond Crossman Run, north of Trade City. From there the axis begins a descent that varies from about 15 feet to 30 feet per mile. It passes south of Gamble School, north of White Oak Sehool, erosses Little Mahoning Creek about 1½ miles southeast of Smieksburg, and continues southwestward to just south of Barnards, where the axis is arbitrarily terminated.

The eontrol for the axis of the Punxsutawney syncline eastward from Crossman Run was based largely on the Lower Freeport coal, elevations on whieh were obtained from mine surveys and from diamond core drill holes. Southwestward struetural eontrol is less certain and is based mostly on members of the lower Conemaugh group, supplemented by the depth to the Upper Freeport limestone in some of the wells drilled reeently for natural gas.

Plumville anticline. The Plumville antieline, although a relatively minor fold, is the only structure that lies entirely within the Smieksburg quadrangle. It was given its name after the borough of Plumville in the southwestern part of the quadrangle, through which the axis passes. This upfold begins east of Trade City on the southeast

limb of the Punxsutawney syncline. The axis crosses Route 210, half a mile south of Trade City, rising at approximately 10 feet per mile to a "high" north of McCormick. From that "high" the axis plunges at the rate of about 100 feet per mile to the south side of Little Mahoning Creek northwest of Rossmoyne. From there the plunge averages less than 15 feet per mile and the axis follows the east side of North Branch Plum Creek to near Sagamore, where this anticline appears to die out. The most prominent feature of the Plumville anticline is expressed in the "high" north of McCormick, which is essentially an elongated dome having a closure of about 50 feet.

In the area about Sagamore and Plumville, the structure was determined mostly from mine maps and records of core drilling. The valley of Little Mahoning Creek offered some exposures on the Upper Freeport coal and limestone. Elsewhere, structural control is based on members of the Conemaugh group.

Elders Ridge syncline. The Elders Ridge syncline takes its name from a village in the Elders Ridge quadrangle where that syncline is an almost symmetrical basin. This downfold is one of the major structures in western Pennsylvania and begins in the southwestern part of Westmoreland County, from where it has been traced continuously to its end in the Smicksburg quadrangle, a distance of approximately 50 miles.

The axis of the Elders Ridge syncline enters this quadrangle at the southern border on South Branch Plum Creek. It trends in a nearly straight line deviating little from N. 35° E., and rises rather regularly about 25 feet per mile. It passes about three-fourths of a mile west of Ambrose, just east of Elkin, about half a mile east of Georgeville, and crosses Little Mahoning Creek, one mile northwest of Mottarns Mill. It apparently dies out about 1½ miles east of Trade City, where it appears to be offset from the axis of the Punxsutawney syncline.

The limbs of the syncline are mildly irregular and have a nearly uniform rise, which varies from about 25 feet to about 100 feet per mile. The southeastern limb is steeper than the northwestern limb.

The Elders Ridge syncline has depressed the Allegheny group well below drainage, consequently the control for structure was based largely on the lower members of the Conemaugh group, and control points are somewhat scattered. Therefore, the structure at best may be generalized; it is believed, however, that the structure as indicated is essentially correct.

Richmond anticline. The Richmond anticline is a strong fold named after the village of Richmond in the Punxsutawney quadrangle, where it appears to be a spur of the Chestnut Ridge anticline, which structure is also one of the major folds in western Pennsylvania and has been traced about 150 miles from the Pennsylvania-Maryland boundary into northcentral Pennsylvania.

Only a relatively small part of this anticlinal spur is in the southeastern corner of the Smicksburg quadrangle. The axis emerges from the Punxsutawney quadrangle 0.7 of a mile east of Lowman School,

extends about 1.7 miles across the southeast corner, and enters the Indiana quadrangle 0.7 of a mile east of route 480. It plunges from a "high" contoured at 1850 feet in the Punxsutawney quadrangle, to a "low" contoured at 1000 feet in the Indiana quadrangle, or a relief of something over 850 feet in a lateral distance of 10 miles. The northwest limb of this structure in the Smicksburg quadrangle appears to be fairly regular, and has a strong and nearly uniform dip of about 150 feet per mile to near Pine Run. From Pine Run westward toward the Elders Ridge syncline the dip becomes increasingly less.

Most of the Allegheny group has been elevated above drainage by the Richmond anticline and these strata are exposed in the stream valleys and well up on the hillsides. Data for structural control were, therefore, based primarily on the identifiable members in that group.

In the area about Covode and Marchand there appears to be an upfold with a southwest-plunging axis, which axis enters this quadrangle on Canoe Creek, extends over a low dome south of Covode, passes through and ends about 1½ miles southwest of Marchand. The

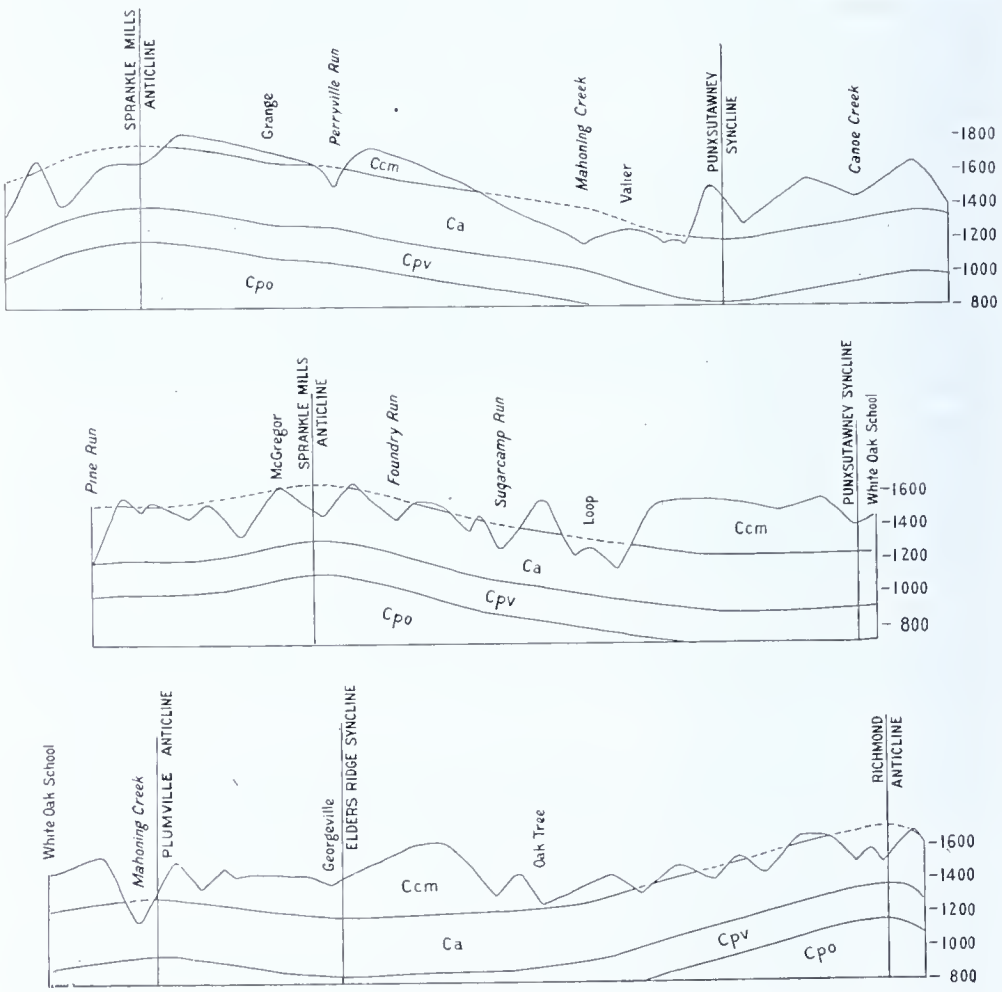


Figure 44. Structure sections across Smicksburg quadrangle.

relationship of this upfold to the structure in the adjoining part of the Punxsutawney quadrangle does not justify its existence as a separate and distinct anticline, but it is rather in the category of an anticlinal bulge on the northwest flank of the Richmond anticline. Structural data in this area are meager and based on the beds in the lower part of the Conemaugh group, supported by a few core drill records.

Subsurface Structure

The subsurface structure of the Smicksburg quadrangle is shown on plates 7, 8, 9, 10. The datum is mean sea level. The contours are drawn at 25-foot intervals on the top of the Catskill red beds ("red rock" of the drillers), which is logged on most of the records of wells drilled for natural gas. The subsurface was based on the top of the "red rock" because it is generally recognized by the drillers and also because of the lenticular character of the gas sands, and the uncertainty of their correlation.

The thickness of the strata occupying the interval between the top of the Allegheny group and the top of the Catskill formation varies considerably in this area. This variation probably is due largely to the Pennsylvanian-Mississippian unconformity. The variation in thickness of this interval of rocks in the Smicksburg quadrangle is shown on the convergence map (fig. 45). This map was constructed by calculating the depth to the Catskill red beds from the horizon of the Upper Freeport coal. Many well records showing the "red rock" also indicated the Upper Freeport or other recognizable horizons in the Allegheny group, thus affording a direct check. There appears to be a wide local range in the Upper Freeport-"red rock" interval. The extreme local ranges are presumed to be due in part to errors in measurements and recording by the drillers, and in part to the possibility that the color change does not always come at the same stratigraphic horizon in the Catskill. Therefore, those intervals that ranged widely in any given locality were discarded and those that were more nearly in accord were averaged, which average was taken as representative of the locality. Where well data are meager or lacking, the thickness contours are necessarily projected, which is indicated on the map by broken lines. The areal difference between the minimum and maximum thickness of the rocks in the Upper Freeport-"red rock" interval is a little over 90 feet; the greater thickness of something over 1510 feet occurs south of Smicksburg, and the lesser thickness of a little under 1420 feet occurs southeast of Marion Center.

The elevations on the top of the "red rock" were determined by using the known areal elevation of the Upper Freeport coal horizon as plotted on the mineral resources and structure map (pl. III), and the area thickness variation from that horizon to the top of the "red rock." By that method, numerous and well distributed structural control points were established, and it is believed that a nearer approach to the true subsurface structure was thus attained. In the area where well data are meager, as indicated by broken lines on the convergence map, the subsurface structure contours in those areas are similarly indicated.

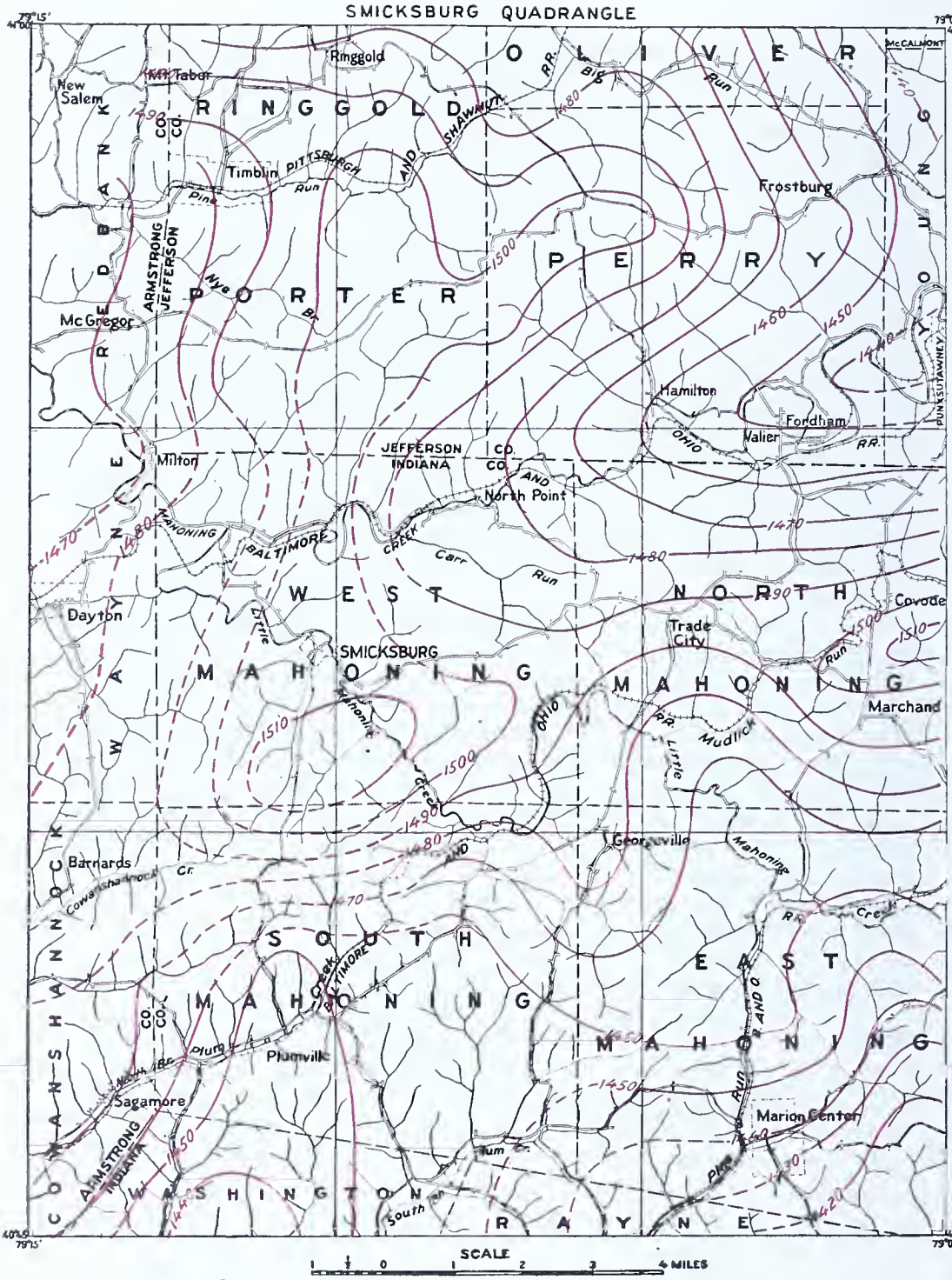


Figure 45. Convergence map showing areal variation in interval between the Upper Freeport coal and the top of the Catskill red beds.

By comparing the surface and subsurface maps, a general accordance in the character of the folds will be noted. This is particularly noteworthy since there are known to be numerous minor local unconformities and at least one major unconformity in the sediments be-

tween the respective contoured horizons. The axes of the folds as drawn on the maps have similar general directional trends and differ only locally; also, there has been relatively little shifting of the axial planes. What may only be coincidental, yet still have some significance, is that, in a general way, the stronger folds occur in the areas of lesser thickness of the Upper Freeport-"red rock" interval, whereas the milder folds occur in the areas of greater thicknesses of that interval.

Faulting

A fault is a fracture along which there has been movement resulting in a break of continuity of masses formerly in contact. The term fault as commonly used by miners in the bituminous coal fields is a misnomer, in that it is applied to an overlying sediment, which is commonly sandstone, that has reduced the thickness of a coal bed or has completely cut it out. This is an erosional and sedimentary feature (local unconformity) and was not caused by tectonic disturbance.

Westward from the Allegheny Front as the folding of the rocks becomes milder, faults also become less frequent in occurrence. Although the folding of the rocks in the Smicksburg quadrangle is relatively strong in some areas, and is locally quite sharp, only minor displacement has been observed.

West of Timblin about 0.2 of a mile, a cut along the Pittsburgh & Shawmut Railroad has revealed a section that exhibits rather intensely folded strata, accompanied by minor displacement. (See figs. 46, 47, 48.) Here the strata have locally been pushed into a high angle of inclination. The length of the section thus disturbed is about 250 feet, and extends east-west; the exposed height is about 12 feet above the grade of the railroad. Normally bedded (channel) sandstone is in contact with the upturned and truncated edges of the sandy shales and lenses of sandstones, and at that contact occur stringers of coal, probably reworked material. Two excellent examples of vertical exfoliation plates are present in the overlying sandstone. Near the east end of the intensely folded part of the section, a thin bed of sandstone has been faulted, but apparently is offset only a few inches. The strike of the fault surface is N. 50° W. and the dip is 12° N. E.; the beds above the fault strike N. 35° E. and dip 55° N. W. Those below strike N. 35° E. and dip 20° N. W. The downfolded coal and underclay is taken to be the Lower Kittanning, and its normal position in the section corresponds to that of the channel sandstone. Similar disturbed zones have been reported to occur in the mines on the Lower Kittanning coal in this area.

A suggested history of geologic events that resulted in the condition of the strata as they appear in the railroad cut west of Timblin is as follows:

1. Normal sequence of deposition in a moderately shallow sea, evidenced by shale, clay, and coaly beds.
2. Lithification under weight of overlying deposits.
3. Local movement creating fold or strong warp in beds at eastern end of cut, those of the western end being very little affected.

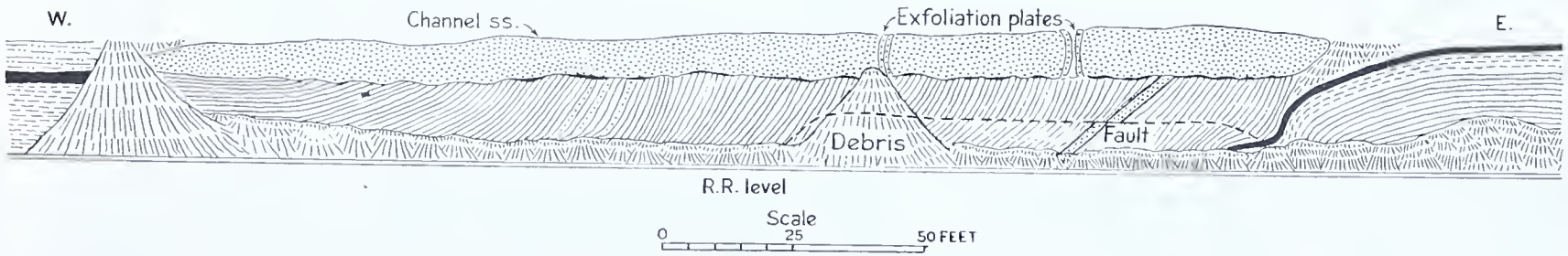


Figure 46. Sketch of section in railroad cut west of Timblin.

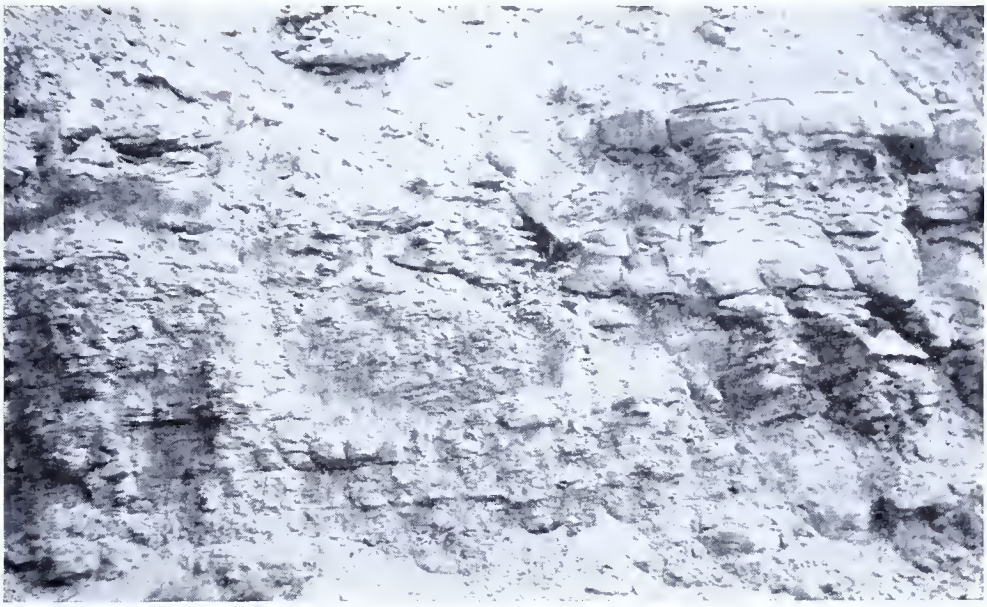


Figure 47. Intensely folded beds in railroad cut west of Timblin.

Figure 48. Fault in intensely folded beds in railroad cut west of Timblin.

4. Contemporaneous with No. 3, and a part of it, the beds were locally displaced along a plane N. 50° W., dipping N. E. 12°. Displacement along this plane caused a drag and consequent steepening of the beds above the observed fault.

5. Erosion and weathering. Excavation of channel.

6. Filling of channel by sandstone, probably in time of flood because the sandstone is massive, single-bedded, and fairly homogeneous.

7. Further deposition and later erosion, including the weathering of the channel in such manner as to create vertical exfoliation plates along joints.

Jointing

Joints are cracks or fractures in the rocks dividing them into blocks; they occur in two or more sets, and the joints in each set are approximately parallel and from a few inches to many feet apart. Little or no slipping occurs between blocks. The interpretation of joints in sedimentary rocks is still a somewhat controversial subject and little acceptable criteria are available with which to make analogies.

The joints in the rocks in the Smicksburg quadrangle were best observed in the face and butt cleats of the coal beds. They probably are compressional in origin, and contemporaneous with the regional folding, which was in late Carboniferous time.

The face cleat is commonly well developed, and it is thought to represent the master joint system. The strike of this cleat varies from N. 40° W. to N. 75° W., and averages N. 55° W. Those directions are approximately the dips of the folds, hence the face cleats are classified as dip joints. The butt cleat is usually poorly developed and frequently indistinct. The strike varies from N. 15° E. to N. 45° E.; the average is N. 35° E. This average makes an angle of 90° with the average direction of the face cleat. These joints are approximately parallel to the axes of the structures, and are, therefore, strike joints. The relationship of the observed joints and the surface structure of the quadrangle is shown on figure 49. All the observable joints were vertical. Any inclination from the vertical is too small to be apparent in the thickness of the coal beds.

Unconformities.

Two types of unconformities were observed in the strata of the Smicksburg quadrangle, both of which are not uncommon in the Carboniferous rocks in western Pennsylvania. They are confined to relatively small areas and are, therefore, called local unconformities.

In the angular type of unconformity, the dip of the adjacent beds is different, which is the result of an interruption in deposition during a period of uplift (probably differential), wherein the exposed beds were tilted and eroded. Following that, there ensued a period of subsidence, and deposition was resumed, the later sediments being deposited on the upturned and eroded earlier beds. The angular type of unconformity is displayed along the Pittsburgh & Shawmut Railroad just west of Timblin. The details have been described in preceding paragraphs on faulting.

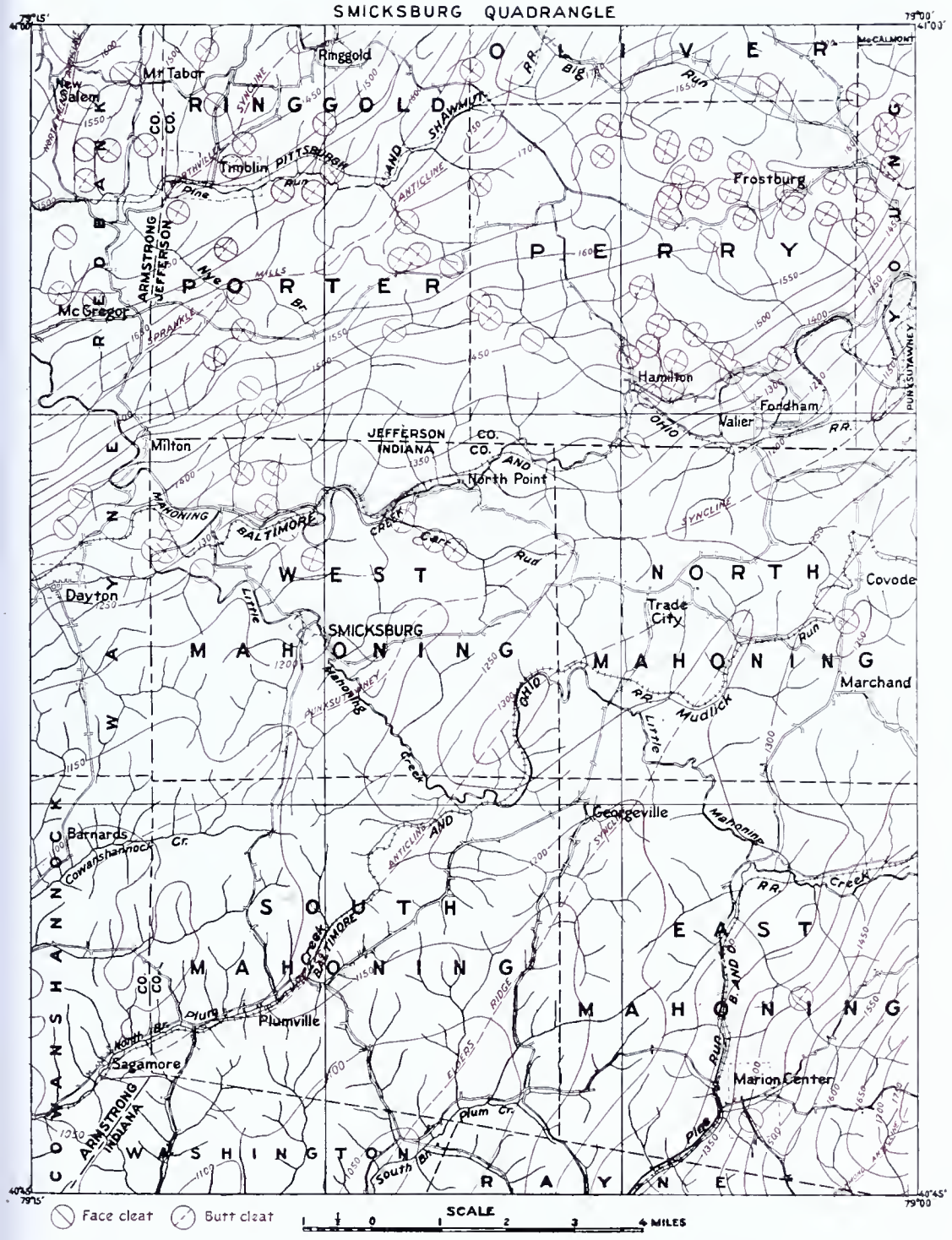


Figure 49. Map showing the relationship of the face and butt cleats to the surface structure.

Cross-bedding, which is common in the sandstones, and caused by current action, may be mistaken for angular unconformity by an untrained observer. Close examination will reveal the relationship between the oblique and horizontal laminations.

The other type of unconformity (disconformity) is very common. It is essentially an erosional and depositional feature, and is revealed by an undulating surface between normally bedded strata. It may have involved emergence and erosion of earlier beds, followed by submergence, and deposition of later beds; or probably more often was caused by subaqueous erosion, i.e., in time of flood, accelerated currents swept away materials that were deposited when the currents were less impetuous. This increased current velocity enabled the waters to carry coarser material, such as sand, which was deposited in place of other finer material. This type of unconformity is exemplified in the "faults" or "rock rolls" in the coal beds; and particularly in the Upper Freeport in this area where the Mahoning sandstone cuts into or has replaced the coal bed. (See fig. 27.)

MINERAL RESOURCES

The following discussion considers the character, quality, and distribution of the mineral resources in the Smicksburg quadrangle. They consist of coal, clay, iron ore, limestone, natural gas, sandstone, shale, soil, and water. In relation to importance, coal is first and natural gas is next. Large reserves of clay underlie the coal beds, but none have been developed. Limestones occur at several horizons; they are generally thin and impure, and have no commercial value, but are being worked locally in a small way for agricultural purposes. Shales and sandstones are in abundance; the shales are, for the most part, sandy; some of the residual sandstone boulders ("field stone") have been used for rough masonry. Thin residual iron ores occur, usually associated with the limestones; some have been dug and smelted in the past, but have no economic value as ores at present. Soils have been discussed briefly under the chapter headed Industries and Towns.

The text descriptions are accompanied by chemical analyses, detailed graphic sections and diagrams, mineral resources maps showing distribution of economically important beds, natural gas maps, and an economic map which shows the position of the outcrops and their relation to near surface structure.

The Mineral Resources Map.

The mineral resources and structure map, plate III, shows the outcrops of the minerals having present or possible future economic value, their relation to each other and to the near surface structure. To facilitate reference between map and text, the map has been divided into a grid forming six vertical and six horizontal 2½-minute rectangles. The vertical rows of rectangles are designated by capital letters, the horizontal rows by small letters. As an example, Da1 refers to a datum point in the fourth vertical row from the left, and

the first horizontal row at the top. The outcrop lines of the important beds are identified on the map by comparing their symbols with those given in the explanation at the right. Thus, the line designated UF shows the outcrop of the Upper Freeport coal. Where the outcrop lines are broken, the bed is missing or its presence doubtful; the discontinued lines indicate that the bed is erratic in occurrence, or not enough data were had to justify drawing the outcrop line farther. The unbroken outcrop lines, however, do not necessarily mean that the presence of a specified bed is certain, or that its outcrop is exposed. In mapping practice, the continuity of a bed is inferred between observed exposures. Commonly, a mantle of soil or talus conceals the outcrop, but the horizon frequently can be traced by seeps from impervious underclay of a coal bed, or by the topographic expression of a bench or terrace.

The patterns on the map show the geologic divisions. The pattern Qal refers to the areas covered by recent alluvium of Quaternary age, which occurs on the flood plains of the streams; the pattern Cem covers the areas underlain by the uneroded rocks of the Conemaugh group, the base of which is bounded by the horizon of the Upper Freeport coal; Cal includes the rocks outcropping in the Allegheny group from the top of the Upper Freeport coal to the base of the Lower Kittanning coal; Ca2 the outcropping rocks of the Allegheny group from the base of the Lower Kittanning coal to the base of the clay underlying the lowermost Brookville coal. The pattern Cpv shows the area of outcrop of the rocks of the Pottsville series, which extends from the base of the Brookville coal to the base of the Connoquenessing sandstone, and Cbg the outcrop of the Burgoon sandstone member of the Mississippian series.

The heavy brown lines on the map represent the near-surface structure contours. They are drawn on the horizon of the Upper Freeport coal, and show the actual surface of that horizon as it would look if all the overlying Conemaugh rocks were removed, and all of the Allegheny rocks restored in the areas where part or all of them have been eroded.

COAL

Origin and Character

Because of the plant impressions that occur in the rocks closely associated with the coal beds, it has long been believed that coal is of vegetable origin. In relatively recent years, microscopic studies not only confirmed that assumption, but have determined the kind of vegetation that constitutes coal. It has also been established that the vegetation that ultimately became coal accumulated in swamps and bogs which commonly covered large areas. The accumulated vegetation was partially decayed, buried under later sediments, and attained various stages in forming coal. The stages are as follows: peat, lignite, subbituminous, bituminous, semibituminous, and anthracite, the end

result being graphite. The kind of coal was determined by various factors, such as weight of overlying sediments, heat, and degree of deformation of the enclosing strata.

Coals have certain megascopic physical characteristics, as color, banding, structure or grain, luster, streak, hardness, fracture, jointing, and specific gravity.

Color. In the mass, and powdered form, all bituminous coals are black.

Banding. Bituminous coals commonly consist of alternating bright and dull irregular bands. The bright bands (anthraxylon) have been determined by the microscope to consist of wood changed into coal, as shown by the woody-cell structures; the dull bands (attritus) consist of small pieces of wood, leaves, branches, and bark, besides pollen grains, spores, and the resinous, waxy, and fatty contents of cells and tissues.

Structure or grain. With the exception of mineral charcoal or "mother coal," which has a cellular structure like charred wood, most of the bituminous coals are massive or have no observable grain.

Luster. Coals differ in luster from a dull black without luster to a vitreous luster like anthracite.

Streak. The color of the streak of bituminous coal is similar to the color of its massive form, which is black. The streak is obtained by rubbing a piece of coal on a plate of unglazed porcelain, or by scratching with a knife.

Hardness. Coals differ in hardness; some are tender or friable, whereas others are tough and break across the bedding plane with difficulty.

Fracture and jointing. Bituminous coals commonly break into rectangular or nearly rectangular to cubical blocks of various sizes. Jointing in coal is exhibited by the face and butt cleats.

Specific gravity. The specific gravity is determined by comparing the weight of coal with the weight of an equal volume of water. The weight of coal in a bed is obtained by multiplying the specific gravity by 62.5 pounds, the weight of a cubic foot of water.

Analysis of Coal

There are two kinds of coal analysis. The ultimate analysis is a strictly chemical process and shows the percentages of the principal elements, as carbon, hydrogen, and oxygen. It is mainly of scientific interest. The proximate analysis is better suited for practical purposes and, aside from the determination of sulphur, strictly chemical processes do not enter into it. Moisture is determined by heating a 1-gram sample in the dried air of an oven at a temperature of 104°

to 110° C. for one hour; the loss sustained is recorded as the percentage of moisture. Volatile matter is found by heating a 1-gram sample in a closed platinum crucible for seven minutes in the hottest flame of a No. 4 Meker gas burner and recording the loss as volatile matter. Ash is determined by completely burning the sample used for the moisture determination and weighing the incombustible portion that remains. Fixed carbon is the difference between 100 and the moisture plus volatile matter plus ash. The heat units are determined by burning in an atmosphere of oxygen a 1-gram sample in a calorimeter. Sulphur alone is determined by a chemical method.

Moisture is contained in coal several ways, such as surface moisture, hygroscopic moisture or that which is held in the pores of the coal, and moisture in a form or forms not clearly understood. Volatile matter in coal is composed chiefly of the combustible gases such as hydrogen, carbon monoxide, methane, and other hydrocarbons. Fixed carbon is what remains after the moisture, volatile matter, and ash in an anlysis are accounted for. Ash is the incombustible solid material remaining after coal is burned. Sulphur is always present in coal in variable quantities up to 8 percent or more. A high ash content of coal is an objectionable impurity because it has no fuel value; it adds to the cost of shipment, as one percent of ash represents about 20 pounds per ton; it increases the cost of ash removal from the furnace, and is in itself capable of forming clinkers.

Analysis of coal does not definitely determine if it has caking qualities.

Analyses of coals in the Smicksburg quadrangle are shown in the following tables. The analyses in tables 1 and 2 were made by the U. S. Bureau of Mines[52]; analyses shown in table 3 were obtained from mine operators, and were made from mine or face samples, and from cores of coals obtained by diamond drilling. Table 1 gives proximate analyses of coals as shipped or delivered; these analyses are prepared primarily for coal consumers. Tables 2 and 3 show proximate analyses of mine or face samples, which represent the coal in place and are intended for use by coal operators. Table 2 shows ultimate analyses of some of the coals.

The tables show analyses only for the coals that are mined commercially, or the Upper Freeport, Lower Freeport, and Lower Kittanning beds. Analyses made from mine samples show these coals to have a range from about 1.0 to 3.2 percent moisture, 28.0 to 39.0 percent volatile matter, 48.3 to 64.0 percent fixed carbon, 3.0 to 15.0 percent ash, 0.6 to 4.1 percent sulphur, and 12,000 to 15,400 B. t. u. The ultimate analyses of these coals show a range from 4.8 to 5.6 percent hydrogen, 73.6 to 86.5 percent carbon, 1.3 to 1.6 percent nitrogen, and 4.0 to 8.2 percent oxygen.

[52] Analyses of Pennsylvania Bituminous Coals: U. S. Bureau of Mines, Technical Paper 590.

Table 1. Proximate analyses of coal as shipped or delivered

Name of mine and operating company	Coal bed	Size of coal	Approximate tons delivered	Proximate analysis, per cent					B.t.u. per pound			Number of analyses averaged	Softening temperature, °F	Number of softening temperatures averaged
				Moisture, as received	Dry coal: Volatile matter	Dry coal: Fixed carbon	Dry coal: Ash	Dry coal: Sulphur	As received	Dry coal	Moisture-free and ash-free			
Sagamore mine, Buffalo and Susquehanna Coal Company	Upper Freeport	Run-of-mine	500	2.9	31.6	55.1	13.3	2.7	12,870	13,250	15,290	1	2,350	1
Do	Do	Run-of-mine (special)	1,040	1.8	32.3	56.1	11.6	2.6	13,290	13,540	15,310	1	2,480	1
Do	Do	4-inch lump	200	2.1	32.4	55.8	11.8	2.9	13,270	13,550	15,370	1	2,360	1
Do	Do	2- by 4-inch egg	300	1.9	32.0	55.4	12.6	2.5	13,170	13,420	15,350	1	2,480	1
Do	Do	2- by 3-inch egg	75	1.7	32.8	55.1	12.1	2.4	13,280	13,510	15,370	1	2,540	1
Do	Do	1¼- by 2-inch nut	200	2.0	32.2	55.4	12.4	2.6	13,170	13,450	15,350	1	2,460	1
Do	Do	¾- by 1¼-inch stoker	150	2.1	32.4	56.0	11.6	2.4	13,290	13,580	15,370	1	2,460	1
Do	Do	2-inch nut and slack	150	1.9	32.7	55.4	11.9	2.4	13,270	13,530	15,360	1	2,530	1
Do	Do	1¼-inch nut and slack	350	2.2	32.8	55.8	11.4	2.9	13,310	13,610	15,370	1	2,400	1
Do	Do	¾-inch slack	150	3.7	31.7	58.1	10.2	2.7	13,290	13,790	15,370	1	2,360	1
Do	Do	Slack	2,313	2.4	32.1	56.4	11.5	2.7	13,220	13,540	15,300	9	----	----
Savan No. 1 mine, Savan Collieries Company	Upper and Lower Freeport	Run-of-mine	6,216	1.8	31.3	58.5	10.2	3.7	13,570	13,820	15,390	23	----	----
Perry Hills mine, Perry Hills Coal Company	Lower Freeport	Run-of-mine	15,075	3.7	31.8	58.9	9.3	2.5	13,360	13,870	15,290	38	----	----

Vega No. 1 mine, Vega Coal Company	Do	Run-of-mine	150	2.9	30.8	58.8	10.4	3.8	13,400	13,800	15,300	2	2,210	2
Lindsey No. 8, Light Coal Company	Do	Run-of-mine	5,106	3.6	32.2	59.4	8.4	2.8	13,580	14,090	15,380	10	2,280	1
Do	Do	2-inch lump	144	2.0	32.7	59.7	7.6	2.8	13,920	14,200	15,370	1	----	----
Do	Do	1⅛-inch lump	652	1.7	32.9	60.0	7.1	2.6	14,150	14,400	15,500	1	----	----
Do	Do	Do	8,547	1.6	32.1	60.7	7.2	2.7	14,070	14,300	15,410	31	----	----
Do	Do	3- by 6-inch egg	533	2.0	32.6	61.0	6.4	2.4	14,140	14,430	15,420	3	----	----
Do	Do	1- by 4-inch egg	409	2.1	29.6	62.8	7.6	2.8	14,000	14,300	15,480	1	----	----
Do	Do	Do	261	1.9	31.8	60.6	7.6	2.1	13,930	14,200	15,370	3	----	----
Do	Do	1- by 2½-inch nut	454	2.4	31.0	61.4	7.6	2.2	13,850	14,190	15,360	2	----	----
McWilliams No. 2, Rose-McGregor Coal Company	Lower Kittanning	Run-of-mine	23,124	3.9	35.4	54.4	10.2	3.6	13,160	13,690	15,240	68	2,220	2
Dora mine, Dora Coal Company	Do	Do	250	2.6	33.2	60.3	6.5	1.1	13,980	14,350	15,340	1	2,570	1
Do	Do	Do	50	2.2	33.8	59.4	6.8	1.0	14,030	14,350	15,400	1	2,720	1
Markle-Bullers mine, Markle-Bullers Coal Company	Do	Do	300	2.5	32.3	59.7	8.0	1.1	13,690	14,040	15,260	1	2,680	1
Ringgold mine, Ringgold Coal Company, Jefferson County	Do	2½- by 8-inch egg	50	2.2	35.5	56.9	7.6	2.2	13,910	14,220	15,400	1	2,170	1
Do	Do	1½- by 2½-inch nut	45	2.2	35.5	56.5	8.0	2.0	13,820	14,140	15,370	1	2,400	1
Do	Do	⅜- by 1½-inch nut	115	2.5	33.4	54.8	11.8	1.9	13,140	13,480	15,270	1	2,580	1
Do	Do	Nut-stoker	12,777	1.5	34.9	58.1	7.0	1.9	14,050	14,260	15,330	26	2,150	2
Do	Do	⅜-inch slack	60	4.2	31.9	56.4	11.7	2.3	12,900	13,460	15,240	1	2,470	1

Table 2. Proximate and ultimate analyses of coal mine samples

Name of mine, operating company and location in mine	Sample: Name of coal bed	Sample: Laboratory number	Sample: Sample condition[1]	Proximate per cent: Moisture	Proximate per cent: Volatile matter	Proximate per cent: Fixed carbon	Proximate per cent: Ash	Ultimate per cent: Sulphur	Ultimate per cent: Hydrogen	Ultimate per cent: Carbon	Ultimate per cent: Nitrogen	Ultimate per cent: Oxygen	Air-dry loss, per cent	B.t.u.	Ash-softening temperature °F
Hollow No. 3 mine, Summit Coal Co., 2 room, 2 butt heading; 3 west entry	Upper Freeport	81579	1	2.4	34.9	55.2	7.5	2.0					1.2	13,830	2,190
Back heading, 10 left entry		81580	1	3.2	34.4	54.2	8.2	1.7					2.0	13,580	2,280
Face of 1 room, 6 west entry		81581	1	2.2	32.8	54.1	10.9	2.4					1.2	13,280	2,280
Composite of 81579 to 81581		81582	1	2.7	34.0	54.4	8.9	2.0	5.1	74.8	1.3	7.9	1.5	13,570	
			2		34.9	55.9	9.2	2.1	5.0	76.9	1.3	5.5		13,950	
			3		38.4	61.6		2.2	5.5	84.6	1.5	6.2		15,350	
Sagamore No. 17, Buffalo and Susquehanna Coal Co., left rib, 22 left heading, 2-C heading	Do	81575	1	2.0	32.9	57.2	7.9	2.5					.9	13,740	2,240
Face of 25 right heading		81576	1	3.0	33.4	53.9	9.7	2.6					1.9	13,370	2,280
Left rib, 17 right heading		81577	1	2.5	35.7	55.9	5.9	1.7					1.4	13,980	2,350
Composite of 81575 to 81577		81578	1	2.5	34.2	55.4	7.9	2.3	5.3	76.4	1.5	6.6	1.4	13,740	
			2		35.1	56.8	8.1	2.4	5.1	78.3	1.5	4.6		14,080	
			3		38.2	61.8		2.6	5.6	85.2	1.6	5.0		15,330	
Mill No. 2 mine, Mill Coal Co., right rib, near face of 1 left heading	Do	81568	1	2.7	34.0	55.4	7.9	2.1					1.2	13,610	2,540
Face of Snuff heading		81569	1	2.3	35.6	53.3	8.8	2.7					1.0	13,550	2,240
Right rib, near Gilbert heading		81570	1	2.5	35.5	53.6	8.4	2.8					1.1	13,560	2,070
Composite of 81568 to 81570		81571	1	2.7	34.8	54.2	8.3	2.5	5.2	74.4	1.4	8.2	1.1	13,550	
			2		35.8	55.7	8.5	2.6	5.0	76.4	1.4	6.1		13,920	
			3		39.1	60.9		2.9	5.5	83.5	1.6	6.5		15,210	

Light No. 1 mine, Light Coal Co., left rib, near main heading	Lower Freeport	81501	1	2.4	28.9	55.9	12.8	3.6					1.6	13,030	2,240
Left rib, near shaft heading		81502	1	3.5	31.1	53.2	12.2	4.1					2.7	12,980	2,280
Left rib, 75 feet from 4 main		81503	1	2.9	33.3	57.7	6.1	2.2					1.8	13,900	2,280
Composite of 81501 to 81503			1	3.0	31.0	55.6	10.4	3.2	5.0	73.6	1.4	6.4	2.0	13,300	
			2		32.0	57.3	10.7	3.3	4.8	75.8	1.4	4.0		13,700	
			3		35.8	64.2		3.7	5.4	84.9	1.6	4.4		15,340	
Williams No. 1 mine, Williams Run Coal Co., 2 right, 1 left heading	Do	75753	1	3.0	32.5	59.9	4.6	1.4					1.9	14,180	2,450
1 right, left heading		75754	1	2.8	32.5	60.1	4.6	1.1					1.6	14,220	2,440
Face of main heading		75755	1	2.1	32.7	59.5	5.7	1.1					1.1	14,030	2,540
Composite of 75753 to 75755		75756	1	2.7	32.9	59.2	5.2	1.1	5.3	79.6	1.5	7.3	1.5	14,180	
			2		33.8	60.8	5.4	1.2	5.2	81.8	1.5	4.9		14,570	
			3		35.7	64.3		1.2	5.5	86.4	1.6	5.3		15,390	
Dora mine, Dora Coal Co., right rib, 1 right heading, main heading	Lower Kittanning	81572	1	3.1	33.2	57.4	6.3	1.1					1.5	13,840	2,570
Left rib, 1 room, 3 right heading		81573	1	2.9	32.5	57.1	7.5	1.2					1.3	13,660	2,450
Composite of 81572 to 81573		81574	1	2.9	33.2	57.0	6.9	1.2	5.3	77.0	1.4	8.2	1.4	13,720	
			2		34.2	58.7	7.1	1.2	5.2	79.3	1.5	5.7		14,140	
			3		36.9	63.1		1.3	5.6	85.4	1.6	6.1		15,220	
Markle-Bullers mine, Markle-Bullers Coal Co., face of 3 right heading	Do	A-23	1	2.7	33.0	59.5	4.8	.9					1.6	14,220	2,800
Face of northeast main heading		A-24	1	2.8	32.2	59.9	5.1	.9					2.0	14,160	2,740
Face of main heading		A-28	1	2.2	33.0	59.4	5.4	.8					1.3	14,190	2,850
Composite of A-23, A-24 and A-28		A-25	1	2.6	32.7	59.6	5.1	.8	5.3	79.8	1.5	7.5	1.6	14,190	
			2		33.5	61.3	5.2	.8	5.1	81.9	1.5	5.5		14,570	
			3		35.4	64.6		.9	5.4	86.5	1.6	5.6		15,370	

[1] 1, sample as received; 2, dried at a temperature of 105° C.; 3, moisture- and ash-free.

Table 3. Proximate analyses of coal mine samples and diamond drill cores

	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	B.t.u. as received	B.t.u. dry basis
1	2.20	34.30	55.00	8.50	1.49	13,289	13,555
2	1.18	36.26	54.43	8.13	1.59	----------	13,790
3	1.39	36.01	54.11	8.49	1.48	----------	13,713
4	10.9	31.10	46.87	11.13	.58	----------	11,265
5	1.39	34.83	56.21	7.57	1.72	13,800	13,999
6	1.80	32.70	50.20	15.30	4.13	12,716	12,945
7	.95	36.55	52.89	9.61	1.01	13,595	----------
8	1.41	33.29	54.25	11.05	1.42	13,094	13,225
9	.70	34.55	53.28	11.47	3.36	13,310	----------
10	.65	34.10	53.75	11.50	2.20	13,480	----------
11	1.14	33.30	57.28	8.28	2.39	13,899	14,037
12	4.15	34.75	58.04	3.06	.81	14,452	15,078
13	1.89	33.87	55.34	8.90	1.80	13,579	13,715
14	1.15	34.70	57.75	6.40	1.09	13,831	13,969
15	1.90	30.10	59.50	8.50	.67	13,476	13,611
16	.80	33.50	58.10	7.60	3.67	14,200	----------
17	1.00	33.50	60.50	5.00	1.38	14,225	14,453
18	1.70	35.20	54.90	8.20	2.28	13,495	13,630
19	1.80	37.00	50.20	11.00	3.90	13,177	13,309
20	3.00	33.60	59.30	3.80	.57	13,392	13,847
21	1.00	32.20	59.00	7.80	.72	13,858	13,997
22	1.38	31.00	56.85	4.77	.78	13,285	13,950
23	1.00	38.40	55.40	5.20	1.08	13,507	13,723
24	2.00	30.40	57.20	10.40	1.25	13,862	14,145
25	1.38	38.12	55.29	5.21	2.50	14,362	14,563
26	1.10	36.50	52.30	10.10	2.76	13,348	13,485
27	1.20	36.80	51.50	10.50	3.50	13,098	----------
28	1.30	33.20	56.80	8.70	2.34	13,981	14,121

1. Upper Freeport, country bank (Aa25). Bed 48 inches thick. Composite of 3 channel samples.
2. Upper Freeport, Hallett Coal Co. stripping (Aa46). Bed 48 inches thick.
3. Upper Freeport, Hallett Coal Co. stripping (Aa46). Bed 48 inches thick.
4. Upper Freeport, Hallett Coal Co. stripping (Aa46). Bed 48 inches thick.
5. Upper Freeport, McGregor No. 1 mine (Aa47). Bed 48 inches thick.
6. Upper Freeport, diamond drill hole, .5 mile northwest of Ringgold. Bed 33 inches thick.
7. Upper Freeport, country bank, Yarger farm (Ab6). Bed 48 inches thick. Composite of 3 channel samples.
8. Upper Freeport, country bank, Elkins farm (Bb27). Bed 48 inches thick. Composite of 3 channel samples.
9. Upper Freeport, country bank, Snyder farm (Bb26). Bed 44 to 48 inches thick. Composite of 2 channel samples.
10. Upper Freeport, country bank, Kunselman farm (Bb26). Bed 50 inches thick. Composite of 3 channel samples.

11. Upper Freeport, country bank, Barnett farm on Hamilton Run 0.7 mile southeast of Porter. Bed 48 inches thick. Composite of 2 channel samples.
12. Lower Freeport, stripping, Geist farm (Aa41). Bed 50 inches thick.
13. Lower Freeport, country bank, Kunselman farm (Bb24). Bed 45 inches thick.
14. Lower Freeport, country bank, Powell farm (Bb25). Bed 48 inches thick. Composite of 2 channel samples.
15. Lower Freeport, country bank, Kroh farm, Hamilton Run, southeast of Porter. Bed 36 inches thick. Composite of 2 channel samples.
16. Lower Freeport, country bank. Weaver farm (Dc19). Bed 36 to 40 inches thick.
17. Lower Freeport, Freebrook Coal Co. stripping, 1 mile east of Hamilton. Composite of 2 channel samples.
18. Lower Freeport, Freebrook Coal Co. stripping (Ea29). Bed 42 to 46 inches thick.
19. Lower Freeport, Freebrook Coal Co. stripping (Da42). Bed 36 to 46 inches thick.
20. Lower Freeport, Freebrook Coal Co. stripping (Ea20). Bed 47 inches thick.
21. Lower Freeport, country bank (Fa45). Bed 58 inches thick. Composite of 2 channel samples.
22. Lower Freeport, Freebrook Coal Co. stripping, 1.8 miles northeast of Frostburg.
23. Upper Kittanning, Hallett Coal Co. stripping (Ba4). Bed 48 to 60 inches thick.
24. Upper Kittanning, diamond drill hole, Parr farm, 2.2 miles northwest of Frostburg.
25. Lower Kittanning, McGregor No. 2 mine (Aa50).
26. Lower Kittanning, diamond drill hole, .5 mile northwest of Ringgold. Bed 40 inches thick.
27. Lower Kittanning, diamond drill hole, .5 mile northeast of Ringgold.
28. Lower Kittanning, Freebrook Coal Co. stripping (Bc16). Bed 30 to 48 inches thick.

Classification of Coals

To meet the needs of both scientific and commercial interests, coals have been classified according to their inherent properties and composition.[53] 1. By rank, or according to the degree of metamorphism, or progressive alteration in the geological series from lignite to anthracite. 2. By grade, or according to quality as determined by calorific value, ash and sulphur content, ash-softening, size, etc. 3. By type or variety such as common banded, splint, cannel, and boghead or algal coals. The high-rank bituminous coals and anthracite are classified according to fixed carbon on the dry basis, and the lower-rank bituminous, subbituminous and lignite coals according to B. t. u., on the moist basis—that is, containing its natural bed moisture, but free from visible surface moisture. The proximate analysis of coal was used. On the basis of this classification, coals are divided into

[53] American society for testing material. Report of sectional committee on classification of coals, 1934.

four major classes, each class of which is further divided into two to five groups.

The coals in the area embraced by this report fall within class II bituminous and only that part of the table of classification of coals by rank is shown below.

Classification of bituminous coals by rank

with limits of fixed carbon or B. t. u., mineral-matter-free basis.

1. Low-volatile bituminous coal
   Dry F. C., 78% or more and less than 86% (Dry V. M., 22% or less and more than 14%.)
2. Medium-volatile bituminous coal
   Dry F. C., 69% or more and less than 78% (Dry V. M., 31% or less and more than 22%.)
3. High-volatile A bituminous coal
   Dry F. C., less than 69% (Dry V. M. more than 31%); and moist B. t. u., 14,000 or more.
4. High-volatile B bituminous coal
   Moist B. t. u., 13,000 or more and less than 14,000.
5. High-volatile C bituminous coal
   Moist B. t. u., 11,000 or more and less than 13,000.

F. C. Fixed carbon, V. M. Volatile matter, B. t. u. British thermal units.

History of Mining

Commercial coal mining began in Jefferson County in 1882 when the Buffalo, Rochester & Pittsburgh Coal Co. opened their mines at Walston. Commercial mining began in the Smicksburg quadrangle in 1887 with the opening of the Berwind-White Coal Company's West Eureka mines in the valley of Mahoning Creek between Valier and Punxsutawney. Those mines were practically exhausted by 1908, and the Berwind-White Coal Co. withdrew from the field. The recovery of the remaining virgin coal and the pulling of stumps and pillars were taken over by local companies. Soon after the turn of the century other mines, financed by local capital, were opened in this area. Toward the close of the 19th century, the Punxsutawney field was one of the largest producers of bituminous coal in the State. Coking operations were also one of the largest in the State. At Walston there were 657 ovens in a single bank nearly 1¼ miles long.

Following the completion of the extension of the Buffalo & Susquehanna Railroad to Sagamore, the Buffalo & Susquehanna Coal & Coke Co. began shipping coal from their Sagamore mines in 1905. These mines were in continuous operation up to 1943, when they were taken over by another company. The Dayton Coal Co. also opened their mines at Dayton in 1905. These mines were followed by the Summit Coal Co. mines near Dayton in 1907.

The grade for the Pittsburgh & Shawmut Railroad, which follows Pine Run in the northwestern part of the Smicksburg quadrangle, was started in the fall of 1909 and the rails were laid in 1912. This railroad was constructed primarily to serve operations of the Allegheny River Mining Co., which is a subsidiary of the Pittsburgh & Shawmut

Railroad Co. Previous to the construction of this railroad, a few country coal banks in the valley of Pine Run were producing coal for local consumption. Shortly after the completion of the railroad, the Eagle Valley mine was opened and was the first mine to ship coal by rail in this area. Other commercial mines were opened soon thereafter. Coal production in this area reached its peak in the early 1920's, and since that time has steadily declined. Very little coal is being produced in this area in the 1940's, since most of the economically recoverable coal has been removed, and some operations have failed for various causes.

Coal Production

The production of coal in the Smicksburg quadrangle by year and by mine is given in table 4. These data were taken from the reports of the Pennsylvania Department of Mines and represent only the coal produced by commercial mining operations, or from the mines that come under the State mining laws. The production of coal from the mines not under State law, such as the numerous country banks in this area, could not be even approximately determined; and although many of these small operations were begun long before the large commercial mines were opened, the quantity of coal produced from them is believed to be relatively small, since they supplied only the local needs in a sparsely populated area. Also, since the beginning of commercial operations, a considerable amount of the coal consumed locally was purchased from those mines. It is believed, therefore, that the unknown amount of coal produced in the quadrangle would not greatly increase the reported total tonnage.

Based on the reported tonnage, the production of coal increased irregularly from approximately 300,000 tons in 1888 to approximately 1,978,000 tons in 1923. U. S. entry into World War I greatly accelerated the production. From the peak in the boom years following the war, production declined regularly to about 571,000 tons in 1938. With the beginning of World War II, production began to increase at the rate of about 10,000 tons per year, and in 1943 a little over 1,000,000 tons were shipped to markets. The reported total quantity of coal produced by mines in the quadrangle up to and including 1943 is approximately 51,653,000 tons.

General Discussion

Although coal for many years has been a great source of mineral wealth in this region, the field is long past its prime and the coal industry is rapidly declining. Most of the coal economically mineable at present standards is practically exhausted, and only a few commercial mines were operating in 1944.

Most of the mines in the quadrangle are drifts, a few are slopes, and two are shafts; all the slope and shaft mines are worked out and abandoned. The tipples are wooden or steel structures, and some are quite modern. The room and pillar method of mining is generally practiced and retreat robbing is prevalent. Coal is mined by cutting and punching machines, and by hand pick. Many of the mines have

been electrified, and electric locomotives have replaced mule haulage. The power is developed at the mine or purchased from public utility companies. A few mines are equipped with sizing and cleaning plants, but the greater part of the coal is sold as run-of-mine, and shipped to markets in New York State, New England and Canada. Numerous custom and country banks supply the local needs and the coal is transported to consumers by truck.

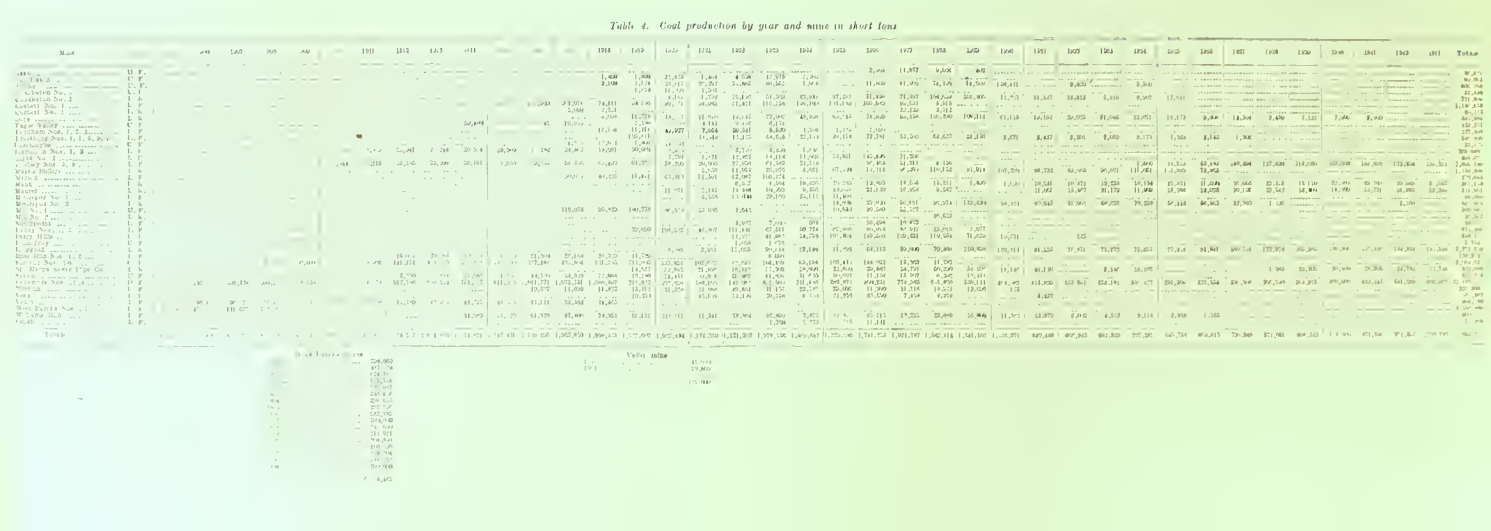
Beginning about 1939 and continuing through 1944, coal stripping operations contributed largely to the increase in production in the quadrangle. Some of these operations were on essentially small virgin tracts of coal, whereas others stripped "crop" coal which had not been recovered by earlier underground mining.

In general practice, the economic limit for removal of cover or overburden on a proposed coal-stripping project is determined by a rule-of-thumb method, which is, one foot of overburden to one inch of coal. Some operators, in applying that method of appraisal, apparently failed to consider that the character and condition of the rock constituting an overburden necessarily modify that rule. It is obvious that the cost of removing massive sandstone, which had to be prepared for removal by drilling and blasting, would be considerably more than the cost of removing soft shale. An overlying sandstone may cut into and reduce the thickness of a coal bed. The dip of a coal bed is also an important factor to consider, as it controls the width of the strippable area.

Power shovels, usually with a 2½ cubic yard capacity, make the opening cut; in some operations scrapers or bulldozers are used to remove the soil and loose rocks. The cuts vary in width from about 30 to 80 feet. They are started some distance in from the outcrop, as it has been found that coal under less than 8 feet of cover is likely to vary in quality or be otherwise affected by weathering. The dug material is dumped on the surface toward the outcrop. Usually one-half of the coal is removed from the initial cut, and waste material from successive cuts is deposited where the coal has been removed. Large operations employ two or more shovels, and power coal-loading shovels follow the stripping shovel. Bony and other material on top of the exposed coal missed by the power shovel is cleaned by hand shovel. However, it is difficult to avoid all extraneous impurities, which with the inherent impurities greatly increase the ash content; although most of the strip coal is under the acceptable limit of 8.5 percent for general industrial purposes. Coal exceeding the high ash limit must be mixed with low ash coal to make a marketable product.

The coals occurring in the Smicksburg quadrangle are predominantly the soft bituminous or in class II bituminous, and fall within group 3 high-volàtile A bituminous coal, and group 4 high-volatile B bituminous coal. They are commonly of the banded type, the bright bands being relatively larger than the dull bands. The coal is generally friable, but much of it breaks into blocks of variable sizes. It mines out from 20 to 60 percent lump, 20 to 40 percent not in lump, and 25 to 60 percent slack. Some of the coals are long-grained, that is,

Table 4. Coal production by year and mine in short tons



the coal mines out in blocks which have the greatest length at right angles to the bedding plane. A few of the thinner coals were noted to mine out in "sticks," or the entire thickness of the bed. The coals may be free from visible impurities, but as a rule, contain one or more partings or binders of bone, shale, or clay, which vary in thickness from a knife edge to over 12 inches. Iron sulphide ("sulphur") in the form of marcasite and less often as pyrite occurs in lenses and balls. These impurities are usually gobbed in the mines.

The commercially mined coals range in thickness from about 30 inches to over 10 feet. In local coal mining parlance, a thick coal is called a "high" coal, and a thin coal is a "low" coal. In actual measurements, however, the maximum thickness delimiting a "low" coal is arbitrary; and the thickness of coal is referred to as being 20 inches "high," 40 inches, 60 inches "high." Coal mining technique has shown that it costs 50 cents per ton more to produce from a 36-inch bed than a 60-inch bed, 35 cents per ton more to produce from a 42-inch bed than a 60-inch bed, and 25 cents per ton more to produce from a 48-inch bed than a 60-inch bed.

The cost of operating a cleaning and sizing plant ranges from 10 to 20 cents per ton of coal, which includes maintenance, depreciation, interest, and labor. Rejects, which range from about 5 to 12 percent and go to the gobb pile, increase mining costs from 10 to 25 cents per ton.

Although the coals in the Smicksburg quadrangle do not fall within the limits of ideal steam coals, many of them serve sufficiently well for that purpose. Ideal steam coal is a combination of high-calorific value with small smoke- and clinker-producing, as well as long-burning qualities. The volatile matter should be high enough to permit rapid response to stimulated firing. More than 2 percent sulphur has a tendency to lower the fusion point and cause clinkering of the ash. High sulphur will also affect the storing qualities of the coal.

Cannel coal occurs in small amounts in this area and is associated with the bituminous coal beds. It is not a true cannel coal, but rather a cannelloid or bird's-eye variety. The word cannel is believed to be a corruption of the word candle, and is so called because a thin slice of cannel coal will ignite quickly and burn with a long, yellow flame like a candle. A true cannel coal is fine-grained and massive with satiny or velvety sheen. It mines out in blocks, breaks with a conchoidal fracture, has a brown-black streak, and is clean to handle. Its chief use is for burning in open grates, and because it is resistant to weathering, has been used for building foundations. Cannel coal was formed from the deposition and partial distillation or oxidation of large quantities of plant spores, pollen grains, and more or less commuted remains of low orders of plants and animals which were floated and wind-blown into lagoons, channels, or basins.

Since all the coals occurring in the quadrangle were briefly discussed under the foregoing chapter, Stratigraphy, the ensuing detailed discussion is confined to those coals considered to have present or possible future economic value.

Table 5 was compiled from data on the coals indicated on the records of wells drilled for natural gas. The accuracy of the measurements of the depth of the coals from the surface, and the thickness of the coal beds is generally questionable, but the correlation of the coals is, for the most part, considered to be fairly accurate. However, it must be emphasized that these data be used with caution. They are presented primarily as a guide for future exploration, and reference to them in the text descriptions is intended to mean that their existence is probable.

Table 5. Data on coal from gas well logs

Township	Well No.	Plate	Upper Freeport	Lower Freeport	Upper Kittanning	Middle Kittanning	Lower Kittanning	Clarion	Brookville	Mercer	Limestone Flint clay?
Redbank	2	7							360 4		
Redbank	5	7							350 5		
Redbank	11	7							370 10		
Redbank	15	7								435 4	
Redbank	20	7					210 4				
Ringgold	1	7	4								
Ringgold	15	7	4								
Ringgold	22	7					230 3				
Ringgold	30	7			100 4		240 3				
Ringgold	31	7				140 5				400 6	
Ringgold	33	7								400 3	410 5
Ringgold	29	7								415 5	
Ringgold	21	7				130 4					
Ringgold	8	7	4		100 4						
Ringgold	16	7					230 5				
Ringgold	26	7							365 7		
Ringgold	19	7					220 5				
Ringgold	25	7							365 4		
Oliver	5	8							365 2	410 4	
Oliver	4	8					240 3	300 5			
Oliver	10	8							370 4		
Oliver	8	8							380 3		
Oliver	11	8							370 4		
Oliver	17	8					250 3				
Oliver	9	8					230 3		350 4		
Oliver	20	8							370 4		
Oliver	22	8				155 3					
Porter	14	7								425 6	
Porter	13	7			95 3		210 5	300 5			
Porter	12	7				165 2					
Porter	44	7							360 3		
Porter	43	7	4		95 4	175 3					
Porter	36	7		45 4				280 4			
Porter	35	7			100 3						
Porter	33	7	6			175 3			330 4		390 25
Porter	15	7		45 5							
Porter	31	7	3	45 4			250 3				
Porter	16	7							350 6		
Porter	29	7						320 4			
Porter	28	7			70 2	175 3					
Porter	27	7				175 4					
Porter	18	7							360 5		
Porter	7	7		45 3							
Porter	6	7			95 3						
Porter	4	7					210 2		365 6		
Perry	37	8		45 3				290 3			
Perry	82	8				150 3		305 6			
Perry	113	8					230 3		365 5		
Perry	114	8					230 4				
Perry	145	8				135 4					
Perry	148	8				175 3					
Perry	176	8				135 3					
Perry	173	8				155 3					
Perry	115	8							365 4		
Perry	45	8			80 3			325 5			

Table 5. Data on coal from gas well logs (continued)

Township	Well No.	Plate	Upper Freeport		Lower Freeport		Upper Kittanning		Middle Kittanning		Lower Kittanning		Clarion		Brookville		Mercer		Limestone Flint clay?	
Perry	86	8							120	3	240	6								
Perry	108	8							140	6							400	5		
Perry	87	8													365	4				
Perry	29	8													365	5				
Perry	10	8									230	4								
Perry	27	8			50	2			155	4					365	5				
Perry	183	8									210	3	275	3	350	4				
Perry	186	8							120	5										
Perry	136	8					95	3												
Perry	135	8									220	5								
Perry	156	8							170	4										
Perry	157	8			45	3			135	4										
Perry	105	8											295	3						
Perry	90	8											305	3						
Perry	103	8													365	5				
Perry	91	8											330	4						
Perry	52	8			50	4														
Perry	65	8											330	4						
Perry	24	8			50	2	80	5	150	5										
Perry	23	8					80	3												
Perry	60	8									235	3								
Perry	94	8											315	6						
Perry	96	8									235	3								
Perry	57	8									230	4								
Perry	128	8							120	4	225	3								
Perry	129	8													350	3				
Perry	130	8													355	5				
Young	8	8													370	5				
Young	9	8							165	4										
Young	12	8													360	5				
Wayne	5	7													360	3				
Wayne	8	7							140	3										
West Mahoning	2	7					100	3												
West Mahoning	3	7							175	3					340	7			410	12
West Mahoning	10	7							165	5										
West Mahoning	32	7									235	5								
West Mahoning	28	7		3	50	4														
West Mahoning	16	7		4																
West Mahoning	27	7			55	4														
West Mahoning	23	7											290	3						
West Mahoning	22	7			60	4														
West Mahoning	18	7			60	4														
West Mahnoing	14	7			60	3														
West Mahoning	20	7			55	4														
West Mahoning	42	10			50				115	4										
West Mahoning	32	10											290	3						
West Mahoning	31	10											300	4						
West Mahoning	14	10					100	3												
West Mahoning	25	10											310	2						
West Mahoning	1	9			60	3														
West Mahoning	9	9															390	3		
West Mahoning	8	9											315	4						
West Mahoning	6	9													360	4				
West Mahoning	5	9											290	4						
West Mahoning	4	9															380	4		
West Mahoning	22	10											315	5						
West Mahoning	10	10											290	4						
West Mahoning	9	10											300	5						
West Mahoning	8	10			50	3														
West Mahoning	5	10					90	3												
West Mahoning	6	10					95	4												
West Mahoning	19	10					95	3					315	5					390	8
North Mahoning	1	8									230	3	300	4						
North Mahoning	6	8									230	3								
North Mahoning	18	8									225	3			365	2				
North Mahoning	2	8									240	4								
North Mahoning	17	8					85	5	185	3										
North Mahoning	21	8			45	6														
North Mahoning	31	8			45	5					225	5								

Table 5. Data on coal from gas well logs (continued)

Township	Well No.	Plate	Upper Freeport		Lower Freeport		Upper Kittanning		Middle Kittanning		Lower Kittanning		Clarion		Brookville		Mercer		Limestone Flint clay?	
North Mahoning	47	8					110	5												
North Mahoning	58	8			45	3			130	3										
North Mahoning	53	8									240	5								
North Mahoning	48	8					100	5												
North Mahoning	44	8													365	5				
North Mahoning	33	8					95	5												
North Mahoning	30	8			45	4					230	4								
North Mahoning	11	8			45	3														
North Mahoning	8	8									220	3	300	4						
North Mahoning	24	8											290	3						
North Mahoning	27	8							135	3										
North Mahoning	29	8					100	3												
North Mahoning	36	8									240	6								
North Mahoning	75	8									220	5								
North Mahoning	70	8			45	4														
North Mahoning	46	9			45	3														
North Mahoning	5	9					90	4			230	3								
North Mahoning	4	9							130	4	220	4								
North Mahoning	19	9							185	4										
North Mahoning	20	9									240	4								
North Mahoning	36	9									230	4								
North Mahoning	38	9							165	3										
North Mahoning	47	9									245	4								
North Mahoning	57	9			45	3														
North Mahoning	62	9	4																	
North Mahoning	76	9	4																	
North Mahoning	44	9	3																	
North Mahoning	15a	9			45	4														
North Mahoning	14	9									230	4								
North Mahoning	30	9									255	3			355	3				
North Mahoning	32	9									240	3								
North Mahoning	49	9					90	7	155	3										
North Mahoning	73	9							145	4										
North Mahoning	75	9			40	3														
Cowanshannock	2	10			40	4					240	5								
Cowanshannock	3	10	4								245	3			345	3				
Cowanshannock	10	10	4		45	3					210	6								
Cowanshannock	8	10	1								215	6								
Cowanshannock	7	10	5						160	4										
Cowanshannock	13	10	5						165	5										
Cowanshannock	14a	10	6						160	5										
Cowanshannock	18	10	5				100	4												
Cowanshannock	24	10	5						170										450	5
South Mahoning	17	10					85	3			205	3								
South Mahoning	48	10							125	4										
South Mahoning	1	9					90	3												
South Mahoning	2	9											290	4						
South Mahoning	18	9					90	3					285	5						
South Mahoning	19	9											280	4						
South Mahoning	3	9					100	4												
South Mahoning	17	9									225	3								
South Mahoning	15	9									230	5								
South Mahoning	55	10									205	5								
South Mahoning	56	10									210	4								
South Mahoning	33	10			45	4														
South Mahoning	22	10		2			90	3												
South Mahoning	62	10					90	10			255	3	310	3						
South Mahoning	59	10									230	6								
South Mahoning	31	10					115	2												
South Mahoning	64	10									250	4								
East Mahoning	3	9			50	3			170	4										
East Mahoning	4	9													370	4				
East Mahoning	3	9													380	5				
East Mahoning	21	9							165	5					370	4				
East Mahoning	42	9							205	4										
East Mahoning	63	9									250	6								
East Mahoning	62	9							150	3										
East Mahoning	90	9							130	2					365	4				

Table 5. Data on coal from gas well logs (continued)

Township	Well No.	Plate	Upper Freeport		Lower Freeport		Upper Kittanning		Middle Kittanning		Lower Kittanning		Clarion		Brookville		Mercer		Limestone Flint clay?	
East Mahoning	117	9		4																
East Mahoning	137	9		3			90	4	115	3										
East Mahoning	121	9					100	3												
East Mahoning	70	9									225	4								
East Mahoning	69	9									225	4								
East Mahoning	60	9							175	2					360	4				
East Mahoning	43	9							155	2					385	5				
East Mahoning	38	9			45	2							300	4						
East Mahoning	22	9									220	4								
East Mahoning	8	9									215	3	310	10						
East Mahoning	16	9									230	3			360	4				
East Mahoning	9	9									220	3								
East Mahoning	15	9							125	6					345	3				
East Mahoning	34	9									225	3								
East Mahoning	36	9									225	3			340	3				
East Mahoning	56	9			50	5							305	4						
East Mahoning	57	9							175	3							425	4		
East Mahoning	55	9																		
East Mahoning	54	9									220	5								
East Mahoning	85	9					105	3							350	5				
East Mahoning	96	9							150	4										
East Mahoning	95	9					100	3												
East Mahoning	113	9							125	3					320	4				
East Mahoning	123	9											305	5						
East Mahoning	97	9							125	2	250	4					445	4		
East Mahoning	98	9					100	3					295	2						
East Mahoning	125	9					105	3												
East Mahoning	110	9											305	4			425	3	430	4
East Mahoning	99	9					100	3	130	3	230	4								
East Mahoning	84	9					90	2	160	3										
East Mahoning	49	9			45	3	100	3	165	3					375	6				
East Mahoning	11	9									250	4								
East Mahoning	27	9			40	2														
East Mahoning	45	9			45	3														
East Mahoning	52	9							150	3										
East Mahoning	46	9																		
East Mahoning	50	9																	475	8
East Mahoning	100	9											305	4						
East Mahoning	109	9							160	2	225	4			320	5				
East Mahoning	126	9					100	3												
East Mahoning	133	9							165	4	215	4								
East Mahoning	127	9									220	5								
East Mahoning	128	9													335	3				
East Mahoning	101	9					100	5												
East Mahoning	83	9		4	50	4														
East Mahoning	49	9							150	3										
East Mahoning	48	9							170	4										
East Mahoning	29	9											300	4						
East Mahoning	12	9							120	4	240	5			370	5				
East Mahoning	13	9															410	5		
East Mahoning	79	9											305	4						
East Mahoning	102	9							145	3							420	5		
East Mahoning	106	9			50	2														
East Mahoning	104	9			55	3														
East Mahoning	107	9			50	2	110	2							355	4				
East Mahoning	131	9									235	5								
East Mahoning	105	9					110	3							350	5				
Washington	9	10		4					160	2	240	2					460	2		
Washington	8	10		6					160	3					380	5				
Washington	11	10		4																
Washington	12	10		3																
Washington	14	10		5																
Rayne	18	10													370	4				
Rayne	1	9									225	3								
Rayne	2	9									230	3	295	4						
Rayne	4	9					100	3			225	5								
Rayne	5	9					95	3							340	3				

UPPER FREEPORT COAL

The Upper Freeport is a valuable coal and has been an important producer in this region. The horizon of this bed underlies about 151 square miles of the Smicksburg quadrangle, of which about 35 square miles are underlain by workable coal, or approximately 125,000,000 tons. Up to and including 1943, about 29,000,000 tons have been removed by commercial mining operations. If only the amount of coal thus produced could be considered, there would remain about 95,000,000 tons, but the unknown production from country coal banks probably would appreciably reduce that tonnage. However, from reports and field observations, it appears that the better quality and thicker coal is near depletion.

Where normally developed, the thickness of the Upper Freeport varies little from 48 inches. The general average is about 38 inches, and the known maximum thickness is 84 inches. The Mahoning sandstone reduces the thickness of the coal or cuts it out locally. The coal may be clean at some places, but as a general rule contains one or more impurities. It commonly is characterized by up to 24 inches of bony at the top, which comes down with the coal in mining. In areas of its thickest development, the bed may be separated into two benches by up to 17 inches of bony, which usually occurs in the upper part of the bed. A shale or bone binder averaging about three-fourths of an inch thick and occurring near the bottom of the coal is fairly persistent. Lenses of "mother coal" and "sulphur" are common. The coal is nearly everywhere underlain by clay, and the roof is either shale or sandstone.

The Upper Freeport has a fairly uniform quality throughout the quadrangle, but is exceedingly poor locally. Available mine or face analyses show the following variations:

Analyses of Upper Freeport coal, in percent

	Low	High	Average
Fixed carbon	48.1	61.8	55.0
Volatile matter	32.7	39.1	34.9
Ash	7.5	15.3	9.4
Sulphur	1.0	4.1	2.2
Moisture	0.7	3.2	2.0

The Upper Freeport coal is missing from sizable areas in the quadrangle. The present streams have removed approximately 74 square miles of the Upper Freeport horizon. Its absence is probably due in part to erosion by stream action relatively soon after deposition, as exemplified by being replaced by the Mahoning sandstone; but it is believed to be due largely to nondeposition as previously described. The general distribution and thickness of the Upper Freeport coal is shown on figure 50.

The Upper Freeport coal has a mineable thickness in four distinct areas in the quadrangle, and for convenience of description, the coal is discussed with respect to five districts. They are the Pine Run district in the northwest, the Mahoning Creek district north and west of Northpoint, the Dayton-Smicksburg district in the west, the Sagamore district in the southwest, and the Marion Center district in the southeast.

Figure 50. Map showing general distribution and thickness of the Upper Freeport coal.

Pine Run District

The Pine Run district includes the area in the northwestern part of the quadrangle drained mostly by Pine Run and its tributaries. The horizon of the Upper Freeport crops out well up on the hillsides;

it underlies a considerable area in this district, but the coal is present eastward to about three-fourths of a mile east of Ringgold and to near the head of Middle Branch.

The Upper Freeport is irregular and faulty in this district. It ranges in thickness from a film to 54 inches. Where it has its normal thickness of 48 inches, it is immediately overlain by 8 to 10 inches of bony. The Mahoning sandstone is generally well developed and commonly constitutes the cap rock.

From 1916 to 1927 the Upper Freeport underwent considerable commercial development in this district and over 2,000,000 tons of this coal was produced. The coal removed contained from 8 to 11 percent ash, and from 1½ to 2 percent sulphur. Although large areas are still underlain by coal, the results of prospecting indicate it is very faulty and contains higher ash and sulphur.

Three patches of Upper Freeport coal, comprising about 86.4 acres occur east and south of New Salem between Mudlick and Sugarcamp Runs. The bed is worked for house coal and was reported to be nearly exhausted. A bank was opened on the Troutman farm (Aa25). The coal is clean, 51 inches thick, and overlain by 10 inches of bony (fig. 51, sec. 2). The face cleat bears N. 50° W. An analysis of the coal in this bank shows 8.5 percent ash and 1.49 percent sulphur (see also table 3). A little south of there, the Upper Freeport was opened on the Doverspike farm (Aa29) where it also is clean, has 6 inches of bony on top, but the thickness is reduced to 36 inches (fig. 51, sec. 1). Farther south along the road from New Salem, the coal has been opened on the Kunselman farm (Aa34). The outcrop is exposed at two places still farther south along the road (Aa37, 38), but measurements were not obtainable.

McGregor mine. Between Sugarcamp and Painter Runs, and north of Pine Run, an area of about 736 acres is underlain by the horizon of the Upper Freeport coal. The coal is present but very faulty. The McGregor No. 1 mine (Aa47) worked the coal reportedly from 1921 to 1925 and produced about 100,000 tons. The average daily output was 100 tons; the recovery was 80 percent, and coal mined out in 60 percent lump. The coal is soft and mushy 300 feet in from the outcrop. The normal thickness of the bed is 48 inches, and it has an average of 6 inches of bony at the top, which breaks free from the roof. A nonpersistent sulphur band occurs near the bottom. A measurement obtained 800 feet in the drift at one right heading is shown in figure 51, section 7. An analysis of a sample of coal from this mine shows 7.57 percent ash and 1.72 percent sulphur (see analyses table 3).

The roof is shale at some places in the mine, but generally is sandstone, which pinches out the coal at numerous places. In fact, this operation was abandoned because of the faulty character of the coal. In 1944 the Hallett Coal Co. made a few test openings with a bulldozer on the outcrop of the Upper Freeport near the McGregor No. 1 mine. The results of these tests were all favorable and stripping operations were begun. It was soon discovered that the coal is exceedingly faulty and the project was abandoned. Examination of these cuts disclosed that where overlain by shale—which is up to 8

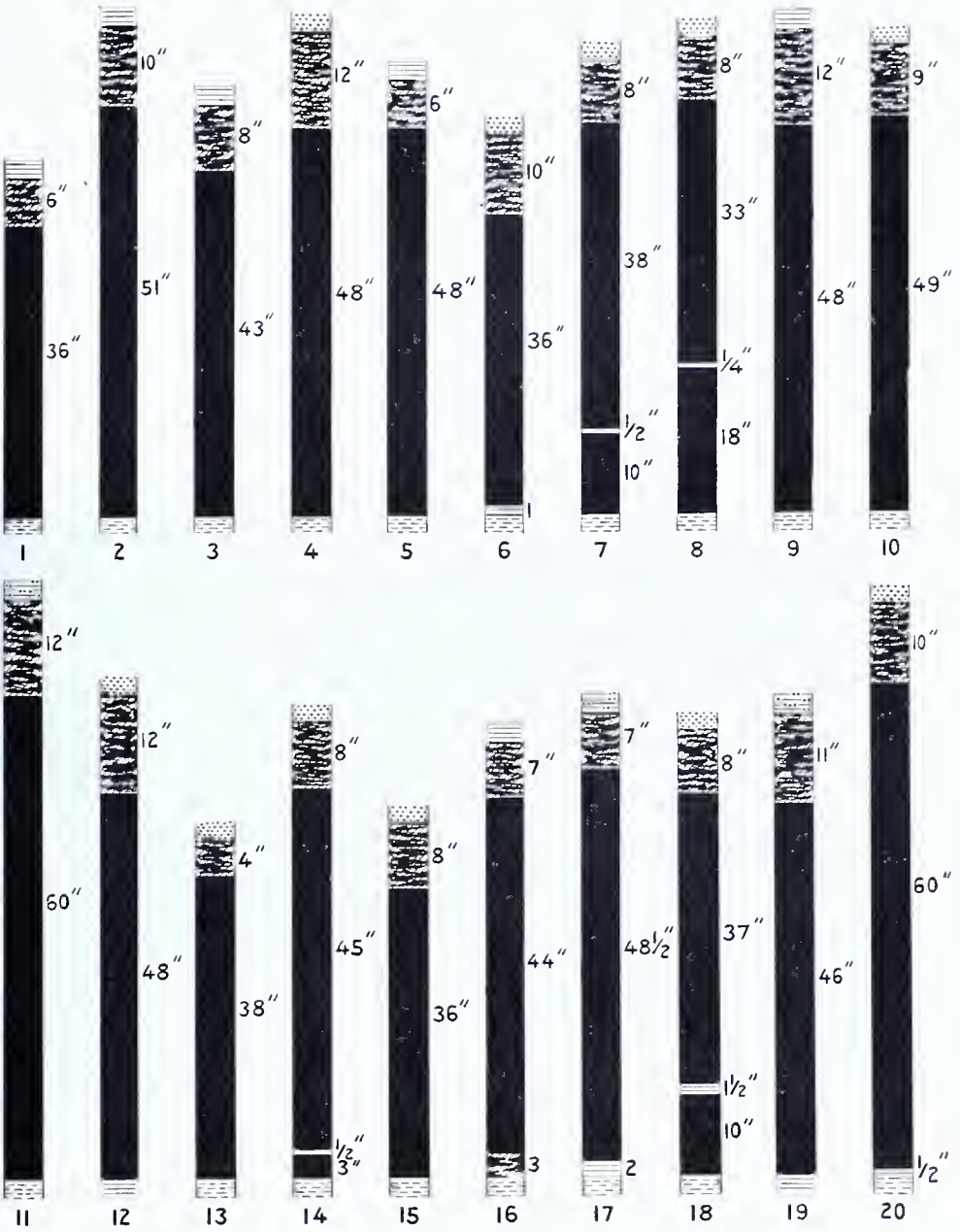


Figure 51. Sections of Upper Freeport coal.

1. Aa29, country bank, Doverspike farm. 2. Aa25, country bank, Troutman farm. 3. Aa18, country bank, Shaffer farm. 4. Aa19, country bank, Shaffer farm. 5. Aa46, country bank. 6. Aa35, country bank, Miuich farm. 7. Aa47, McGregor No. 1 mine. 8. Ba2, country bank, Himes farm. 9. Ba8, prospect pit, Brocious farm. 10. Ba20, country bank, Snyder farm. 11. Ba25, stripping, Sherry farm. 12. Bb4, Gilbert mine. 13. Ba43, country bank, Snyder farm. 14. Ba34, Eagle Valley mine. 15. Ca13, prospect pit, Reed farm. 16. Cb3, country bank, Adams farm. 17. Diamond drill hole No. 3, McClure farm. 18. Ba46, Mill No. 1 mine. 19. Ab3, country bank. 20. Bb51, country bank, Weaver farm.

feet thick—the coal has its normal thickness of 48 inches, with up to 12 inches of bony on top, and breaks into blocks up to 12 inches in greatest dimension. The face of the coal bears N. 41° W., and the butt N. 52° E.

On the hilltop west of the McGregor mine, there appeared to be a virgin tract of Upper Freeport coal. The bed had been worked in a country bank (Aa46), but apparently not much coal had been removed. A little to the north of the country bank, an attempt was made to strip the coal in 1939, but "faults" were encountered and no coal was produced. A section obtained in the cut showed the normal thickness of the coal to be 48 inches (fig. 51, sec. 5). In 1944 the Hallett Coal Co. continued stripping operations on this site, and although numerous "faults" were encountered (fig. 52), a consider-

Figure 52. Mahoning sandstone "faulting" Upper Freeport coal, stripping northwest of Timblin.

able amount of coal was recovered. Where not reduced by rolls, the coal is generally 48 inches thick. It has up to 11 inches of bony on top, and is underlain by an unknown thickness of bluish-gray clay. The coal has a bright luster and contains streaks of sulphur. The face cleat bears N. 50° W., and the butt cleat N. 41° E. Two analyses of the coal from the above mentioned drift where the cover is 24 feet thick, showed 8.13 and 8.49 percent ash, and 1.59 and 1.48 percent sulphur, respectively. An analysis of the coal at outcrop, where the cover is 12 feet thick, shows 11.13 percent ash and 1.58 percent sulphur (see also analyses table 3).

Figure 53. Strip mining Upper Freeport coal, northwest of Timblin.

On the hilltop west of the above location, the Upper Freeport had been worked in a country bank on the Minnich farm (Aa35). The maximum observed thickness of the coal in this bank is 36 inches, with 10 inches of bony on top, and the roof is sandstone. One inch of shale lies directly under the coal, which in turn is underlain by clay (fig. 51, sec. 6). The Peach Hill Coal Co. began stripping operations on the Upper Freeport in this hill in 1944. This operation was not far advanced and no coal had been recovered, when examined by the author; but insofar as could be observed, the success of the project did not appear very hopeful, as most of the coal then exposed is very irregular, being cut into by the Mahoning sandstone, and is also, for the most part, badly decomposed, particularly toward the outcrop and where overlain by sandstone. At a few places in the cut, and especially where the cover is greater, the normal thickness of the Upper Freeport was preserved, it appeared to be free from visible impurities, and is 48 to 58 inches thick.

Mt. Tabor. In the area underlain by Upper Freeport north of Mt. Tabor, the coal was being worked in two country banks on the

Shaffer farm. In the one (Aa18) it is 43 inches thick, has 8 inches of bony on top, which is overlain by shale, and the floor is clay (fig. 51, sec. 3). The face cleat bears N. 50° W., the butt cleat was not distinguishable. In the other bank (Aa19) the coal measured 48 inches, and is overlain by 12 inches of bony. The roof is sandstone and the coal is underlain by clay (fig. 51, sec. 4). The face cleat is well developed and bears N. 55° W.; the butt cleat bears N. 35° E. The Upper Freeport had also been mined for local use at a few other places in this locality (Aa20, 4, 6, 22, 24, Ba11). A poor outcrop was noted on the road north from Mt. Tabor (Aa5).

The horizon of the Upper Freeport underlies about 131.2 acres in the area northeast of Mt. Tabor, lying between forks of Painter Run and extending to the boundary of the quadrangle. The bed was worked for house coal in two banks on the Himes farm. One bank (Ba1) was caved; the other (Ba2) was accessible and revealed 51 inches of coal having 8 inches of bony on top and a sandstone roof. A one-fourth inch binder is in the coal 18 inches from the bottom, and the floor is composed of clay (fig. 51, sec. 8). The face cleat bears N. 50° W., and the butt N. 40° E.

In the area east from Painter Run to Caylor Run and from Pine Run to the northern boundary of the quadrangle, the horizon of the Upper Freeport occupies about 2300 acres. The coal has undergone some commercial development in this area, and is being mined in country banks at various places. The coal remaining after commercial mining was reported to be very irregular and faulty, and nearly everywhere overlain by Mahoning sandstone. The Eagle Valley mine was the first commercial coal mine in the district, and is situated northeast of Timblin (Ba34). This mine was in operation from 1914 to 1923, and produced something over 123,000 tons. The average daily output was about 50 tons. The mine was originally operated as a pick mine with mule haulage and was soon electrified; punching machines operated by compressed air were also installed. The coal was brought down the hill on an incline and dumped into railroad cars. Numerous rock rolls and "faults" occur in the mine. The normal thickness of the coal is 48 inches, and an average of 6 inches of bone coal lies on top, which parts free from the coal. The roof is commonly sandstone, but at some places is shale. Up to 48 inches of clay underlies the coal. Where undisturbed by "rock rolls," the coal was reported to be of good quality. Sulphur streaks are scattered throughout the bed, and a fairly persistent sulphur band occurs near the bottom. A section of the coal was measured 800 feet in on the face of the main heading (fig. 51, sec. 14).

The Corbett Coal Co. operated a mine on the Upper Freeport about 0.3 of a mile north of the Eagle Valley mine (Ba36). Detailed information about this operation is lacking, but it was indicated that the condition of the coal in this mine is similar to that in the Eagle Valley mine. The Upper Freeport had also been worked in two country banks just east of the Eagle Valley and Corbett mines (Ba37, 38). These banks were closed, but it was learned that the coal is very irregular.

Timblin. The Timblin mine, of the Timblin Coal Co., is situated about 0.7 of a mile northeast of Timblin (Ba32, 33). This mine was in operation from 1914 to 1930 and produced approximately 268,000 tons of Upper Freeport coal. The average daily output was 150 tons, and the recovery was 60 percent. The coal mined out in 60 percent lump. Small sulphur bands occur in the coal at some places, but it is usually free from impurities. "Faults" and "rock rolls" are also common in this mine. The roof is nearly always Mahoning sandstone which ranges from about 20 to 40 feet thick; clay, from 3 to 6 feet thick, underlies the coal. The normal thickness of the Upper Freeport in this mine was reported to be 48 inches; draw slate or bone-coal from 4 to 8 inches thick is in contact with the coal at the top and this sometimes sticks to the roof and the coal. The average reported section is as follows: sandstone; bone coal or draw slate, 7 inches; coal, 36 inches; sulphur band, ¼ inch; coal, 10 inches; sulphur band, ¼ inch; coal, 3 inches; plastic clay, 36 to 72 inches.

On the Brocius farm 0.4 of a mile northeast of Timblin, a country bank was open on the Upper Freeport (Ba30) and revealed the rolling nature of the coal. The normal section of the coal in this bank is as follows: roof shale; bony, 12 inches; coal, 14 inches; bone, one inch; coal, 18 inches; bone, one inch; coal, 15 inches; plastic clay reported 0-5 feet. A few feet from where the coal is normal, it is reduced to 4 inches thick by the overlying shale. The Upper Freeport limestone occurs as boulders under the coal at this point, and is separated from it by a few inches of clay shale. The face of the coal bears N. 60° W., the butt N. 35° E.

About 0.4 of a mile northeast of the Brocius bank, on the opposite side of the hill, the Upper Freeport was open on the Snyder farm (Ba20). The coal is 49 inches thick and, so far as could be seen, is free from visible impurities. On top of the coal is 9 inches of bony, over which lies the Mahoning sandstone; the floor is clay (fig. 51, sect. 10). The direction of the face cleat is N. 45° W., the butt is N. 35° E.

The Upper Freeport had been worked at two other places on the Snyder farms (Ba18, 19), but information about the coal was not obtained. The outcrop makes a strong blossom at a point on the road just south of Hauss Church (Ba16) and about 40 feet of massive Mahoning sandstone is above the coal. Outcrops were also located on the road south of B.M.1427 (Ba9). A little to the north of the latter point, the Upper Freeport had been prospected on the Brocius farm (Ba8) and was said to be 48 inches thick (fig. 51, sec. 9). The coal had been worked along Eagle Run southward toward Timblin (Ba15, 22, 24). West of Timblin, and near the point of the hill on the east side of Painter Run (Ba25), the Upper Freeport coal and limestone were being taken out in an open pit on the Sherry farm. The coal near the outcrop is rather well preserved. It is 60 inches thick and has 12 inches of bony on top, which is overlain by an unknown thickness of sandy shale (fig. 51, sec. 11). The top 4 feet of the limestone was exposed 5 feet below the coal, which space is filled with impure clay containing lenses of limonite.

Ringgold. The Upper Freeport had been worked in a drift about 0.4 of a mile west of Ringgold (Ba6). The entry was caved and nothing could be learned about the condition of the coal. The outcrop occurs as blooms on the roads northeast (Ca1) and northwest (Ba5) of Ringgold. On the Michael farm, a little to the west of Ringgold, a core obtained by a diamond drill showed the Upper Freeport to be 33 inches thick. An analysis of the coal gave a high ash and sulphur content (see analyses table 3).

The Upper Freeport had been prospected on the Reed farm east of Ringgold (Ca2) but the coal is not present, apparently having been replaced by the Mahoning sandstone. On the Reed farm southeast of Ringgold the Upper Freeport limestone was quarried (Ca13). The coal had been opened above the lime and was reported as being 36 inches thick (fig. 51, sec. 15). A country bank on the Stewart farm, about 0.7 of a mile west of the quarry on the Reed farm (Ca14), was caved and information in regard to the coal was not obtainable.

Elevated by the west limb of the Sprankle Mills anticline, the Upper Freeport horizon occupies four isolated hilltops comprising about 192 acres on the divide between Caylor Run, the headwater of Pine Run, and two small tributaries of Big Run. It could not be determined if the coal is in the little knoll north of Dora. The Upper Freeport had been worked in a country bank on the Caylor farm along the road running northeast from Dora (Ca22), but its thickness is not known. The outcrop makes a good "blossom" on the same road a little farther to the north (Ca16). The reported results of exploration of the coal in this hilltop are that the bed is thin and pinches out. Personal investigation of the two hilltops still farther to the north failed to find the Upper Freeport coal.

The irregular upland in Porter Township from Pine Run, south to Nye Branch, and northwest of the Porter-Grange road, is underlain by approximately 1,970 acres of Upper Freeport coal horizon. The axis of the Sprankle Mills anticline passes through about the middle of this area and has elevated the coal horizon at one point to 1,675 feet above sea level. The coal bed has been worked in three commercial mines, and crop coal was being taken out in country banks in this area. Although the commercial mines were abandoned, and were in no condition to be entered, it was learned from authoritative sources that the seam is very irregular and faulty, and becomes progressively poorer in quality from west to east. Most of the best coal under this area has been removed. The Mahoning sandstone is the cap rock and has an indicated thickness up to 75 feet (fig. 31). It is usually in contact with the coal, but at some places shale also makes the roof.

As was pointed out earlier in this report, the Upper Freeport coal is missing east of the area under discussion here. The known first appearance of this coal in northeastern Porter Township was encountered south of Middle Branch where it was being worked in a country bank (Cb3) on the Adams farm. The thickness of the measured section is 44 inches; 7 inches of bony is on top, and 3 inches of the same material is at the bottom. The roof is shale and the floor is clay (fig. 51, sec. 16). The face of bed bears N. 60° W. and the butt

N. 35° E. About 0.4 of a mile west of the above location, the Upper Freeport had been opened on the Miller farm (Cb2).

Dora. The Gilbert Coal Co. mine is situated about 0.7 of a mile southwest of Dora (Bb4). It had an average daily output of 500 tons. The coal mined out in 65 percent large lump, with a recovery of about 75 percent. The coal is soft to about 100 feet in from the outcrop; it pinches out on the right side of the main heading and is faulty and irregular in other parts of the mine. The roof is either shale or sandstone, and on top of the coal is 6 to 8 inches of bony, which parts free from the roof and the coal bed; the floor is clay. Sulphur streaks and nodules are scattered throughout, and thin, non-persistent binders are also present. The normal thickness of the bed is 48 inches (see typical section, fig. 51, sec. 12).

The Corbette Coal Mining Co. also worked the Upper Freeport in this area. The entries to the mine are well up on the hill just south of the village of Corbettown (Ba52, 53). The character and thickness of the coal in this mine is reportedly similar to its occurrence in the Gilbert mine, being faulty and irregular. This operation was abandoned in 1924 and, although the mine is not exhausted, it was found economically unfeasible to recover the remaining coal because it was becoming unusually irregular and poorer in quality. The coal removed ranged from about 1.25 to 1.75 percent sulphur, and from 7 to 9 percent ash; that remaining ranged from 2.5 to 6 percent sulphur, and from 9 to 19 percent ash.

A diamond core drill hole on the McClure farm, south of Dora (D.D. hole No. 3) revealed 48½ inches of Upper Freeport with 7 inches of bony on top, which in turn is overlain by sandy shale. The coal is underlain by 2 inches of shale, then clay (fig. 51, sec. 17).

The Mill Coal Co., Mill No. 2 mine is situated about half a mile south of Timblin (Ba46). The Upper Freeport was worked in this mine intermittently from 1917 to 1927. The average daily output was 200 tons, and the total production from the mine is about 500,000 tons. Relatively large areas in this mine were affected by "rock rolls," but where normal, the coal is 48 inches thick. A variable thickness of bony, shale, or sandstone is in contact with the coal at the top; the floor is either shale or clay. Sulphur in lenses and nodules is scattered through the coal. A fairly persistent binder variously composed of sulphur, bone, or shale occurs about 10 inches from the bottom of the bed, and when not cleaned, considerably increases the percentage of ash. The coal mined out in 60 percent fair-sized lumps, and the recovery was about 80 percent. A typical section of the coal in the mine is shown on figure 51, section 18. Analyses of three samples from this mine show 8.3 to 8.8 percent ash, and 2.5 to 2.8 percent sulphur (see analyses, table 2).

Two abandoned country banks on the Upper Freeport coal are located on the D. Snyder farm, a short distance from the Mill No. 2 mine (Ba44, 45). A little farther west on the H. Snyder farm (Ba43), the Upper Freeport was taken out for local use. It has a thickness of 38 inches and apparently is free from impurities; 4 inches of bony overlies the coal. The roof is sandstone and the floor is clay (fig. 51,

sec. 13). The face cleat bears N. 60° W. and the butt N. 30° E. On the opposite side of the hill about 0.4 of a mile south of mill mine, the Upper Freeport had been opened on the Coleman farm (Bb1). About 0.2 of a mile east of the Coleman bank, the coal was being worked on the Weaver farm (Bb51). The bed is rather well preserved at the outcrop. Its maximum observed thickness in this bank is 60 inches. There are 10 inches of bony on top of the coal, and the cap rock is Mahoning sandstone in massive condition. The sandstone rolls down into the coal, and at some places reduces its thickness to 3 inches. Immediately under the coal is 1½ inches of bone, under which is clay (fig. 51, sec. 20). The face of the coal bears N. 60° W. and the butt N. 40° E. The Upper Freeport had been worked for house coal on the Doak farm about one mile east of the Weaver bank (Bb5) and 0.4 of a mile southeast of the Weaver bank on the McDivitt farm (Bb6). It was also worked in a country bank 0.8 of a mile northwest of Porter on the Carmalt farm (Bb16); also, 0.7 and 0.4 of a mile northeast of Porter on the Colman (Cb9) and Bish (Cb10) farms, respectively.

An area of approximately 138 acres is underlain by the horizon of the Upper Freeport on the hilltop south of Pine Run near the western boundary of the quadrangle. The coal appears to be generally present in this area, and has undergone some development, but is reported to be faulty locally.

Charleston mine. The Charleston Coal Co. worked the Upper Freeport in this area in their Charleston No. 1 mine (Ab63) from 1919 to 1921, but produced a total of only 22,000 tons of coal. This, however, was a small hand pick operation, and was abandoned because of faulty character of the coal. The reported normal thickness of the bed is 48 inches, and where normal, the coal is overlain by a variable thickness of bony with a shale roof. The cap rock is massive Mahoning sandstone, which averages from 35 to 40 feet thick; the coal is underlain by an unknown thickness of clay. Sulphur is scattered throughout the coal and a fairly persistent slaty binder half an inch thick occurs about 8 inches from the bottom. The coal was also reported to have a dark lustre, columnar fracture, and to be close grained and medium hard.

The Campbell mine is situated near the top of the hill (Ab10) about 0.8 of a mile east of the Charleston No. 1 mine. This also was a small operation, and was worked during World War I. Information obtained about this mine indicates the normal thickness of the coal to be 48 inches, and is generally undisturbed by rock rolls. Analyses show from 2 to 2½ percent sulphur and from 8 to 10 percent ash. A considerable amount of coal is said to remain.

About 0.3 of a mile west of the Campbell mine, there is an inactive country bank on the Yarger farm (Ab6). The coal is said to maintain its normal thickness of 48 inches; also, to be free from rock rolls. The bed is overlain by 8 inches of bony and underlain by clay. Persons at one time interested in this property had an analyses made of three channel samples from this bank showing 1.01 percent sulphur and 9.61 percent ash (see analyses, table 3). The coal was being worked

in another bank on the Yarger farm about 0.3 of a mile west of the above (Ab3). The seam there is 48 inches thick and 11 inches of bony on top, which is overlain by sandy shale, and the floor is shale (fig. 51, sec. 19). Custom coal had been taken from a bank about 0.3 of a mile still farther west (Ab2); and about 0.3 of a mile southeast of the latter Yarger bank. Another bank, also on the Yarger farm, was caved (Ab7). Two outcrops of the coal were seen along the road that leads south toward McGregor (Ab14).

In the area north of McGregor and south of Nye Branch, the horizon of the Upper Freeport underlies about 185 acres. Investigation of this area revealed but little information about the coal. Only two outcrops occurring as blooms, which could not be measured, were found. The one is on the road descending the hill to Nye Branch (Ab19), and the other is in the lane on the Kunselman farm (Ab21). Some of the natives said the coal had been tested, and is claimed to be present; however, reports regarding the thickness and quality of the coal were conflicting.

Elevated by the Sprankle Mills anticline, the horizon of the Upper Freeport occupies only three small areas in the vicinity of McGregor, comprising about 83 acres. Evidence of the presence of the coal in hilltops west and southwest of McGregor apparently is negative. In the small area underlain by the coal horizon east of McGregor, a bloom of the coal was observed on the road 0.4 of a mile east from the village (Ab30), but indications are that the bed is thin. Some of the residents in this locality seem generally of the opinion that the coal, if present, is probably thin and spotty.

West of Porter and north of the Porter-McGregor road about 121.6 acres is underlain by the Upper Freeport horizon. The coal is known to be present in this area to about 1.2 miles west of Porter. It maintains a workable thickness, but is not particularly good quality. The Upper Freeport was opened on the Elkin farm, 0.8 of a mile west of Porter (Bb27). The bed has its normal thickness of 48 inches, has 8 inches of bony on top, a sandstone roof and a clay floor. An analysis of the coal made for a mine operator, showed 11.05 percent ash and 1.42 percent sulphur (see analyses, table 3). About 0.3 of a mile west of the Elkin bank, the Upper Freeport was being worked in a country bank on the Snyder farm (Bb26). The coal in this bank ranges from 44 to 48 inches thick with 10 inches of bony on top. Mahoning sandstone is the cap rock and clay underlies the coal (fig. 54, sec. 21). An analysis of coal here gave 11.47 percent ash and 3.36 percent sulphur (see analyses, table 3). The face cleat bears N. 40° W., and the butt N. 55° E.

The coal had been worked on the Kunselman farm 0.2 of a mile west of Snyder bank. The section was reported as follows: roof, sandstone; bony, 10 inches; coal, 50 inches; floor, clay of unknown thickness. The coal has 11.5 percent ash and 2.2 percent sulphur (see analyses, table 3).

The hilltop to the north of the above area contains approximately 28.6 acres of Upper Freeport horizon. A country bank on the Howard farm was caved (Bb15), but the coal was said to be 60 inches thick,

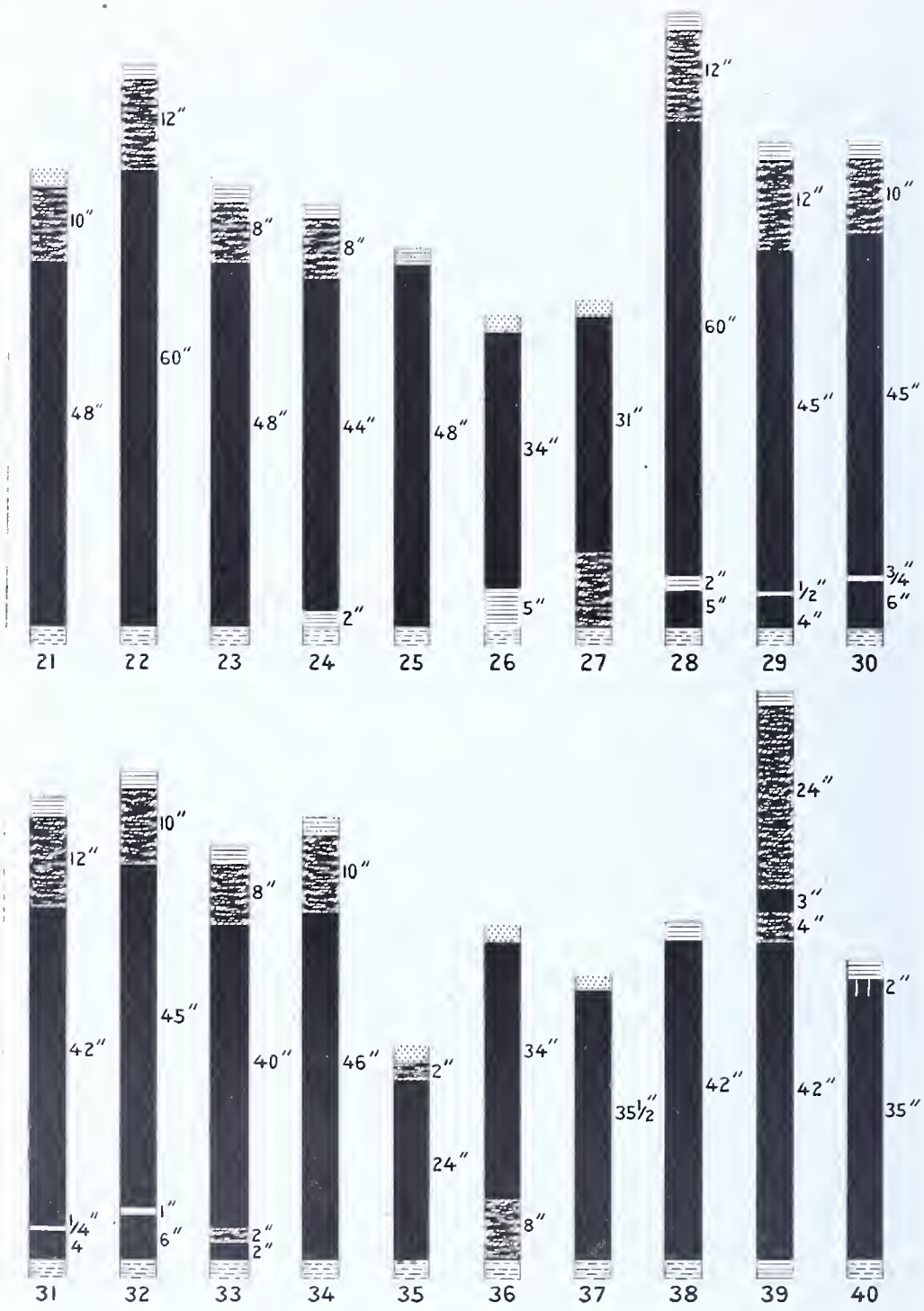


Figure 54. Sections of Upper Freeport coal.

21. Bb26, country bank, Snyder farm. 22. Bb15, country bank, Howard farm. 23. Cb12, country bank, Neal farm. 24. Bb43, country bank, Bish farm. 25. Bb44, country bank. 26. Bc7, country bank, McConnell farm. 27. Bc9, country bank, McDivitt farm. 28. Ac28, country bank, Mathews farm. 29. Ac42, custom bank, Lawson farm. 30. Ac46, Summit mine No. 6. 31. Ac50, Summit mine No. 3. 32. Ac38, Summit mine No. 4. 33. Ac39, Summit mine No. 5. 34. Ac33, country bank, Henry farm. 35. Bc28, custom bank, Bowser farm. 36. Bc19a, custom bank. 37. Bc22, country bank, Gahagan farm. 38. Cc29, country bank, Elkin farm. 39. Cc32, country bank, Elkin farm. 40. Cc34, custom bank, Kerr farm.

having 12 inches of bony on top, a sandstone roof and a clay floor (fig. 54, sec. 22). Coal is partly exposed 3 feet above the Upper Freeport limestone being worked in a drift on the McGregor land (Bb20).

Mahoning Creek District

The Mahoning Creek district includes the area between North Point and Milton that is drained largely by Mahoning Creek and its tributaries. The Upper Freeport coal is irregular and faulty in this district. The outcrop descends steeply on the southeast limb of the Sprankle Mills anticline toward Mahoning Creek, and goes below drainage about 1.3 miles up Carr Run.

Carr Run. The known easternmost extension of Upper Freepot coal in this district was disclosed in a diamond drill hole, located along the north fork of Carr Run (D.D. hole No. 71). The core showed 25 inches of coal overlain by 5 inches of bony, and underlain by clay (fig. 55, sec. 42). The coal is 33 inches thick in a country bank on the south side of Carr Run on the Kerr farm (Cc35). Shale overlies the coal and clay is under it (fig. 55, sec. 41). The face of the coal bears N. 55° W, and the butt N. 35° E. A caved bank on the Upper Freeport is situated on the opposite side of the run (Cc36). A little farther down the run on the south side, the Upper Freeport was being taken out in a custom bank also on the Kerr farm (Cc34). The coal in this mine is 35 inches thick, with from 2 to 4 inches of shaly cannel coal on top; the roof is shale and the floor is clay (fig 54, sec. 40). The face cleat is N. 55° W, and the butt is N. 35° E.

The Mahoning sandstone is massive around the road intersection at B.M. 1226, and occupies the position where, by inference, the crop line of the Upper Freeport is drawn; it appears, therefore, that the coal has locally been replaced by sandstone. The outcrop shows, however, on the road south from the above intersection on the opposite side of the run (Cc33). The coal was observed also at several places on Carr Run a little farther northwest, and had been worked with the limestone at one place (Cc30). North from there, the Upper Freeport was opened in a country bank on the Elkin farm (Cc32) where the coal is separated into two benches by 4 inches of bony; the lower bench being 42 inches thick, and the upper 3 inches thick. The upper bench is overlain by 24 inches of bony. The roof is shale and the floor is clay (fig. 54, sec. 39). The face cleat bears N. 65° W. and the butt N. 25° E.

The Upper Freeport horizon underlies a large area south of Carr Run, but the coal is doubtfully present. As shown by the observations along Carr Run, the bed lacks its normal thickness and feathers out eastward. Also, the records of wells drilled for gas in the area south of Carr Run do not indicate workable coal.

The Upper Freeport coal and limestone were opened on the Elkin place in the bluff on the south side of Mahoning Creek to the west (Cc29). The coal is 42 inches thick, is overlain by shale and underlain by clay (fig. 54, sec. 38). South of Loop, in the bluff where Mahoning Creek makes a sharp bend, the Upper Freeport had been worked at several places. A country bank on the east side of the

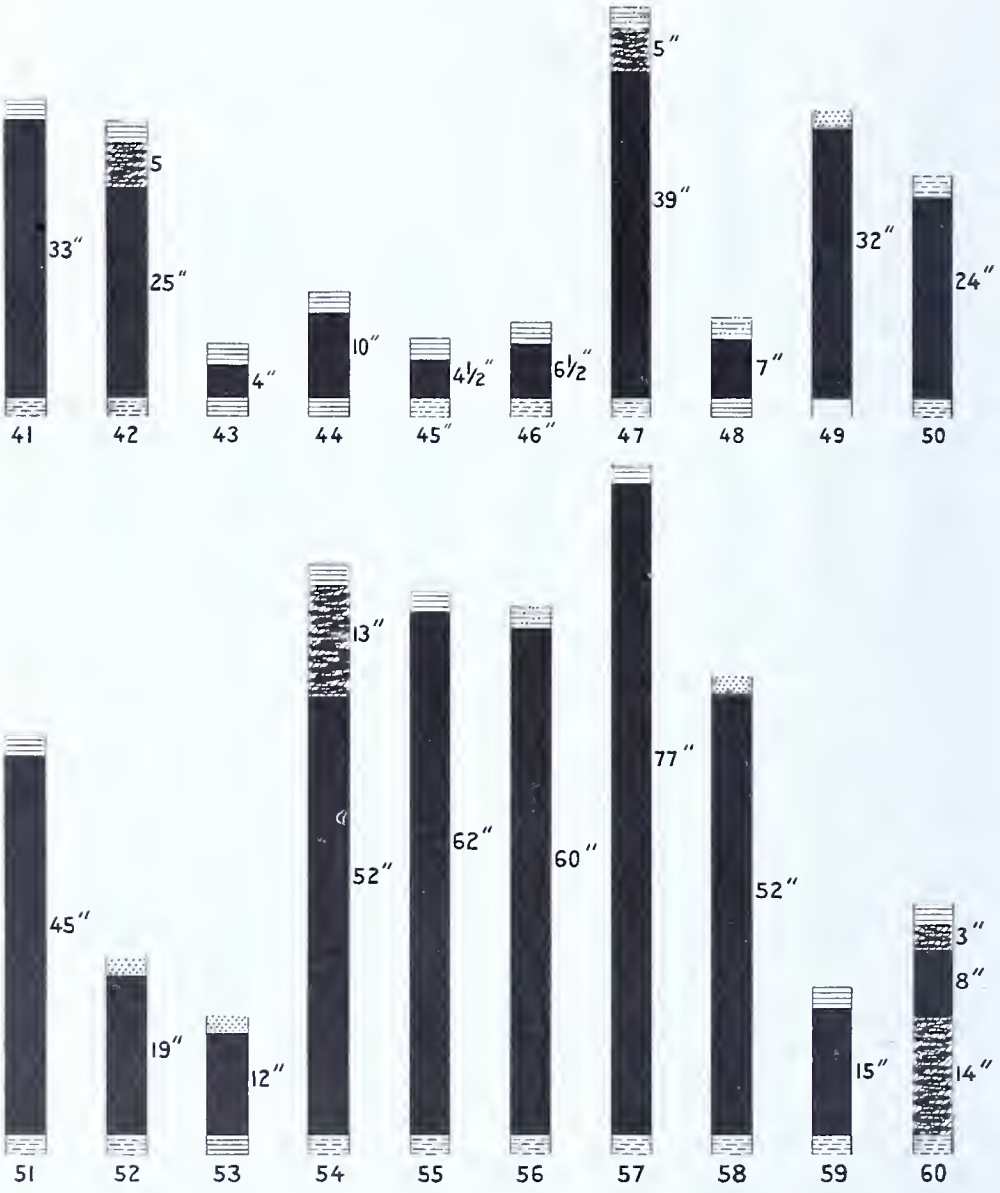


Figure 55. Sections of Upper Freeport coal.

41. Cc35, country bank, Kerr farm. 42. Diamond drill hole No. 71. 43. Diamond drill hole No. 73. 44. Diamond drill hole No. 74. 45. Dd2, outcrop. 46. Ed3, outcrop. 47. Diamond drill hole No. 80. 48. Diamond drill hole No. 81. 49. Diamond drill hole No. 82. 50. Diamond drill hole No. 83. 51. Diamond drill hole No. 94. 52. Diamond drill hole No. 95. 53. Diamond drill hole No. 95a. 54. Diamond drill hole No 93. 55. Diamond drill hole No. 96. 56. Diamond drill hole No. 97. 57. Diamond drill hole No 98. 58. Diamond drill hole No. 99. 59. Diamond drill hole No. 86. 60. Diamond drill hole No. 87.

creek was caved (Cc28), but the coal was said to be 48 inches thick and underlain by 9 feet of plastic clay. The coal was reported to be 48 inches thick in the two caved banks along the hill to the west (Bc39, 37).

An opening had been made on the Upper Freeport on the Skinner place along the road at the point of the hill to the north (Bc21), but the thickness of the coal could not be learned. Just west of that location, a country bank on the Gahagan farm (Bc22) could be entered and the coal had a thickness of 35½ inches. The roof is sandstone and the floor is clay (fig. 54, sec. 37). The face of the coal bears N. 45° W., and the butt N. 50° E.

In this district north of Mahoning Creek, the Upper Freeport horizon underlies two large areas east and west of Hamilton Run. The coal is generally present west of the run, but apparently thins and disappears to the east. The outcrop of the horizon extends about 1.3 miles up the nameless stream east of Hamilton Run. An opening had been made on the outcrop of the Neale farm near the Jefferson-Indiana County line (Cc2). Two abandoned openings are located northeast of Loop near the mouth of Hamilton Run (Cc11, 12), but information about these explorations could not be had.

Hamilton Run. The Upper Freeport crops out along Hamilton Run to its headwaters. The coal had been worked in a country bank on the J. Barnett farm about 1.2 miles up the stream (Cc1). The opening was closed, but the coal was reported to be 48 inches thick. About 0.4 of a mile north of that place, the Upper Freeport was prospected on the E. Barnett farm. The reported thickness is also 48 inches. The coal has 12 inches of bony on top which is overlain by 24 inches of clay shale, then massive sandstone. A reported analysis of the coal indicates 8.28 percent ash and 2.39 percent sulphur (see analysis, table 3).

The Upper Freeport coal was being worked in a drift on the Neal farm a little farther north at the road intersection (Cb12). It is 48 inches thick in this bank, has 8 inches of bony on top, which in turn is overlain by 14 inches of shale; then sandstone. The coal is underlain by clay (fig. 54, sec. 23). The outcrop of the coal was noted on the road westward toward Porter (Cb11) and on the road eastward from the Neal bank (Cb14). The limestone had been worked along the northeast fork of the run (Cb15), but nothing was seen of the overlying coal.

The horizon of the Upper Freeport covers about 1,380 acres between Sugarcamp and Hamilton Runs. Data are meager, but it is possible that workable coal underlies much of this area.

The coal had been worked in a country bank about 0.4 of a mile southeast of Porter on the Minick farm (Cb18) and has a reported thickness of 40 inches. About 0.3 of a mile west of that bank another opening had been made on the Upper Freeport on the same farm (Bb52). The bank had long been caved and the thickness of the coal was not known. About 0.9 of a mile south of Porter on the east side of the road, a caved bank is located on the Elkin farm (Bb50).

On the east side of Sugarcamp Run, close to the county line, about 1.1 miles southwest from where the road crosses the run, the Upper Freeport was being taken out in a country bank on the McConnell farm (Bc7). The coal is 34 inches thick and is overlain by sandstone; 5 inches of shale is under the coal, beneath that is plastic clay (fig. 54,

sec. 26). The face of the coal bears N. 50° W., and the butt N. 35° E. A caved opening (Bc15) on the Upper Freeport is on the McDivitt farm about 0.3 of a mile south of the McConnell bank. On the same farm, 0.4 of a mile southeast of the caved opening, the coal was being mined for local custom trade (Bc19a). The coal measures 34 inches, is capped by sandstone, underlain by 8 inches of bony under which is clay (fig. 54, sec. 36). The face of the coal bears N. 55° W. and the butt is N. 35° E. About 0.4 of a mile to the north, the coal was being worked in a country bank on the McDivitt farm (Bc9). It is 31 inches thick, with sandstone in contact with the coal at the top; 10 inches of bony is at the bottom, and clay is under the bony (fig. 54, sec. 27). The face of the bed bears N. 55° W. and the butt N. 25° E. The Upper Freeport had been opened along the road about 0.4 of a mile northwest of Loop (Bc10). Particles of coal were seen on the dump, but the thickness of the bed could not be learned.

The horizon of the Upper Freeport occupies an irregular area comprising approximately 435 acres, south of the Porter-McGregor road and between Sugarcamp and Foundry Runs. The coal in this area is generally faulty and irregular, and is absent in the northwestern extremity.

Porter. An opening had been made on the outcrop of the Upper Freeport about 0.6 of a mile southwest of Porter (Bb30). Fragments on the dump indicated the presence of coal, but the thickness could not be determined. The outcrop of the Upper Freeport is exposed on the road about 0.4 of a mile south of Fairview School (Bb42). A country bank on the Bish farm, 0.3 of a mile northeast of the above point (Bb43) was open and disclosed 44 inches of Upper Freeport, having 8 inches of bony on top and a shale roof. The coal is underlain by 2 inches of shale, under which is clay (fig. 54, sec. 24). The face of the coal bears N. 55° W.; the direction of the butt was indistinguishable. Although all parts of the workings in this bank were not investigated, the coal appeared to be unaffected by "rock rolls." When this locality was again investigated in 1944, a stripping operation had been started along the outcrop of the coal adjacent to the Bish bank. This operation was soon discontinued because of the faulty and irregular character of the coal bed. Where not affected by "rock rolls," the coal varies little from 48 inches, has a variable thickness of bony at the top, and is overlain by bluish-gray, sandy, micaceous shale up to about 7 feet thick. The shale is overlain by the Mahoning sandstone, which is gray to tan, medium-grained, micaceous, and massive to platy and cross-bedded. The erosional unconformity at the base of the sandstone is very well displayed, and the shale and coal are cut out at numerous places. The above condition of the Upper Freeport may be only local, but it is impressive how one or more favorable indications may mislead an observer as to the true nature of a coal bed.

The Upper Freeport had been opened at three places on the Elkin farm south of the Bish bank (Bc44, 46, 47). These banks were closed and appeared not to have been worked for a relatively long time and information about the coal in them could not be obtained. The Upper

Freeport horizon occupies four isolated hilltops west of Sugarcamp Run. No indication of the coal was seen on the two knobs to the south. The limestone was opened on the two knobs to the north (Bc3, 4), but the coal is missing. The coal horizon underlies a small area in the hilltop west of Foundry Run. A thin "bloom" was noted on the roadside about 0.6 of a mile south of the road intersection at B.M. 1595 (Bb35). The limestone was being worked on the Hooker farm in the little knob to the west (Ab34). The coal is there represented by a thin streak of carbonaceous shale.

Dayton-Smicksburg District

The Dayton-Smicksburg district comprises the area drained by Little Mahoning Creek west of Smicksburg and west of Mahoning Creek below the mouth of Little Mahoning Creek. The Upper Freeport in this district lies generally on the steeply-dipping southwest limb of the Sprankle Mills anticline, which has raised the coal horizon from an elevation of 1225 feet at Smicksburg to about 1450 feet, 1.3 miles north of Dayton; from there northward the horizon of the coal has been eroded.

The Upper Freeport is a fairly good coal in the Dayton area, where it has undergone relatively large scale commercial development and the better part of the bed is mostly mined out. The coal still is being produced in a few custom and country banks. The normal thickness of the coal in this area ranges from about 44 to 48 inches. The known maximum thickness is 65 inches. One or more impurities are usually contained in the coal, and a fairly persistent slaty binder from about one-fourth to 2 inches thick occurs near the bottom. The coal is normally overlain by 2 to 12 inches of bony and is commonly underlain by clay. Rock rolls and faults are numerous and affect relatively large areas of coal at some places.

Dayton. The Summit Coal Mining Company operated mines in the Dayton area. These operations were pursued rather regularly from 1907 to 1928 and something over 3,000,000 tons of coal was produced. The room and pillar system was used and the coal was mined by machine and hand pick.

The No. 1 Mine is situated about 0.4 of a mile northwest of Dayton station, and is just off the Smicksburg quadrangle. This mine was practically exhausted in 1924; in fact, it was reported by Mr. McHenry of Dayton, who was superintendent of the mines, that about one acre only of pillar coal remained. Large areas in the mine were faulted, but where the coal is normal, it is 48 inches thick, has a variable thickness of bony on top and the immediate roof is shale. The cap rock is Mahoning sandstone, which is up to 30 feet thick. The floor of the mine is underlain by 3 to 5 feet of plastic clay. A typical section of the coal in the mine is as follows: roof shale; bony, 8 inches; coal, 43 inches; slaty binder, ½ inch; coal, 5 inches; floor, plastic clay.

The Summit No. 6 mine is located about 1,000 feet north of Dayton station (Ac46). When operating, this mine had an average daily output of 200 tons. The coal mined out in 60 percent lump and the

recovery was 80 percent. When this mine was discontinued, about 30 acres had been mined out of an estimated 65 acres of recoverable coal. The average thickness of the bed is 52 inches and it is fairly regular. From 4 to 8 inches of bony or draw slate overlies the bed and this material parts free from the roof and coal. The immediate roof is shale and the cap rock is Mahoning sandstone. Plastic clay from 3 to 5 feet thick is under the coal. The coal has a medium-bright lustre, is medium hard, and has a columnar fracture. Sulphur bands are scattered throughout and a persistent slaty binder near the bottom is hard to clean and greatly increases the percentage of ash. The section (fig. 54, sec. 30) was measured in the main heading 1,500 feet from entrance.

The No. 3 or Hollow Mine is situated about half a mile east of Dayton (Ac50) where the crop line of the Upper Freeport extends up the hollow. The main heading of this mine was driven into the south side of the hollow in a very large area underlain by the Upper Freeport horizon. The average thickness of the coal in this mine is 44 inches. Its physical characteristics are similar to its occurrence in the No. 6 Mine, other than the slaty binder near the bottom of the coal is not so persistent and "rock rolls" are numerous. Massive Mahoning sandstone up to 34 feet thick forms the cap rock and from 12 to 36 inches of sandy clay is under the coal. The coal mined out in 60 percent lump. The recovery was 60 percent and the average daily output was 350 tons. Something over 350 acres had been mined out. The remaining territory is said to be faulty. An analysis of three mine samples showed 7.5 to 10.9 percent ash, and 1.7 to 2.4 percent sulphur (see analyses, table 2). A section of the coal was obtained 400 feet off the right heading, 4,000 in main heading (fig. 54, sec. 31).

The Upper Freeport coal was exposed in the little ravine above the road just east of the entry of No. 3 Mine (Ac51); and crop coal had been worked in a country bank at the head of a ravine about half a mile northeast of the No. 3 Mine entry (Ac36).

The Summit Coal Mining Company's Nos. 2, 4, and 5 mines are situated along the Baltimore & Ohio Railroad northeast of Dayton (Ac37, 38, 39, respectively). The coal in these workings is practically worked out and the drifts were caved. Each mine had an average daily production of approximately 200 tons. The recoverable coal averaged about 80 percent and it broke out into about 60 percent lump. Relatively large areas in these mines were affected by rock rolls. Normally the bed had an average range in thickness from 42 to 52 inches, is topped by 4 to 10 inches of bony. The immediate roof is composed of a variable thickness of shale, which is capped by 30 to 40 feet of massive Mahoning sandstone. A persistent slaty binder occurs about 6 inches from the bottom. It is difficult to clean, which increases the ash content of the coal. The bed is medium hard, has a medium-bright luster and columnar fracture. Impure clay from 3 to 5 feet thick is everywhere under the coal. The section shown on figure 54, section 32 was measured on face of main heading in No.

4 Mine, 1,000 feet from entry. The section 33 was obtained in main heading in No. 5 Mine, 400 feet in from entry.

Upper Freeport crop coal was being taken out in a small country bank on the Henry farm. The bank is situated east of No. 2 Mine, on the bluff above Little Mahoning Creek (Ac33). The coal is here 46 inches thick and contains numerous lenses of "mother coal"; 10 inches of bony lies on top, over which is 20 inches of sandy shale, then a few feet of thin to shaly Mahoning sandstone is exposed. Clay is under the coal. A graphic section of the bed is shown on figure 54, section 34. The face cleat of the coal bears N. 50° W.

A country bank along the Dayton-Milton road on the Mathews farm (Ac28) was working pillar coal for domestic use. The maximum observed thickness of the Upper Freeport in this bank totals 65 inches. A 2-inch shaly binder occurs 5 inches from the bottom of the bed. Up to 12 inches of bony lies over the coal, which in turn is overlain by shale. The coal is underlain by clay. The section is shown on figure 54, section 28. The Upper Freeport had been worked in another bank also on the Mathews farm (Ac40).

Upper Freeport pillar coal was being mined for custom trade in a bank on the Lawson farm about 0.7 of a mile north of Dayton (Ac42). The seam in this bank is 49 inches thick with 12 inches of bony on top; the immediate roof is shale. A half-inch binder is present and occurs 4 inches from the bottom of the bed. Shaly clay is under the coal. This section is presented graphically on figure 54, section 29. The face of the bed bears N. 45° W. and the butt N. 45° E.

A very small area containing the Upper Freeport horizon lies a little to the north of the Lawson bank. The limestone shows on the road (Ac27), but it could not be determined if the coal is present above. The coal had been taken out in two country banks on the Good and Morrison farms north of Dayton (Ac45, 44).

Smicksburg. The crop line of the Upper Freeport follows up the valley of Little Mahoning Creek, but the coal thins out and at Smicksburg the horizon is represented by a thin streak of carbonaceous shale, which occurs about 15 feet above the accompanying limestone where it is mined just above the creek (Bd4). A poor outcrop of the coal shows on the road that ascends the hill northwest of Smicksburg (Bc34). The coal had been opened in the little ravine on the Crawford place about 0.7 of a mile northwest of Smicksburg (Bc33) and is said to be 4 feet thick. The Upper Freeport is exposed in the lane on the Travis farm about 0.4 of a mile south of Smicksburg station, but is too weathered to be accurately measured (Bc30). A small drift (Bc28) opened on the Bowser farm on the hill overlooking Little Mahoning Creek, about 0.4 of a mile southwest of Smicksburg station, disclosed that the Upper Freeport coal is reduced to 24 inches in thickness, has 2 inches of bony on top, which is overlain by sandstone. The floor is clay (fig. 54, sec. 35). The face of the coal in this bank bears N. 45° W. The butt cleat is indistinct. An attempt had been made to open the coal in the ravine on the south side of the creek, about 0.4 of a mile south of the Bowser bank (Bc29). Evidence indicated the presence of coal, but nothing could be learned

about it. A bloom of the Upper Freeport was seen above the road just a little west of Smicksburg station (Bc27). The coal appeared to have been worked in a small country bank on the Coleman farm about 0.3 of a smile east of Smicksburg station, and on the Laughry farm, 0.3 of a mile north of the latter place (Bc25). Information about the coal at those places was unobtainable.

As previously stated in this report, the Upper Freeport coal is generally thin or missing in the areas immediately adjacent to Little Mahoning Creek. However, a small pocket of Upper Freeport coal occurs on the south side of the creek, northwest of Rossmoyne. The McCombs Coal Company opened two drifts on the coal at this place (Ce2, 3) about 1917, but the operation was continued for only a few years. It was called the Rossmoyne mine. This was a pick mine and had an average daily production of about 50 tons. The reported total production of the mine is approximately 32,000 tons and about 8 acres have been worked out. The Mahoning sandstone is the cap rock. It is massive, coarse-grained to pebbly and is 25 feet thick. Sandstone is nearly everywhere in contact with the coal, reducing

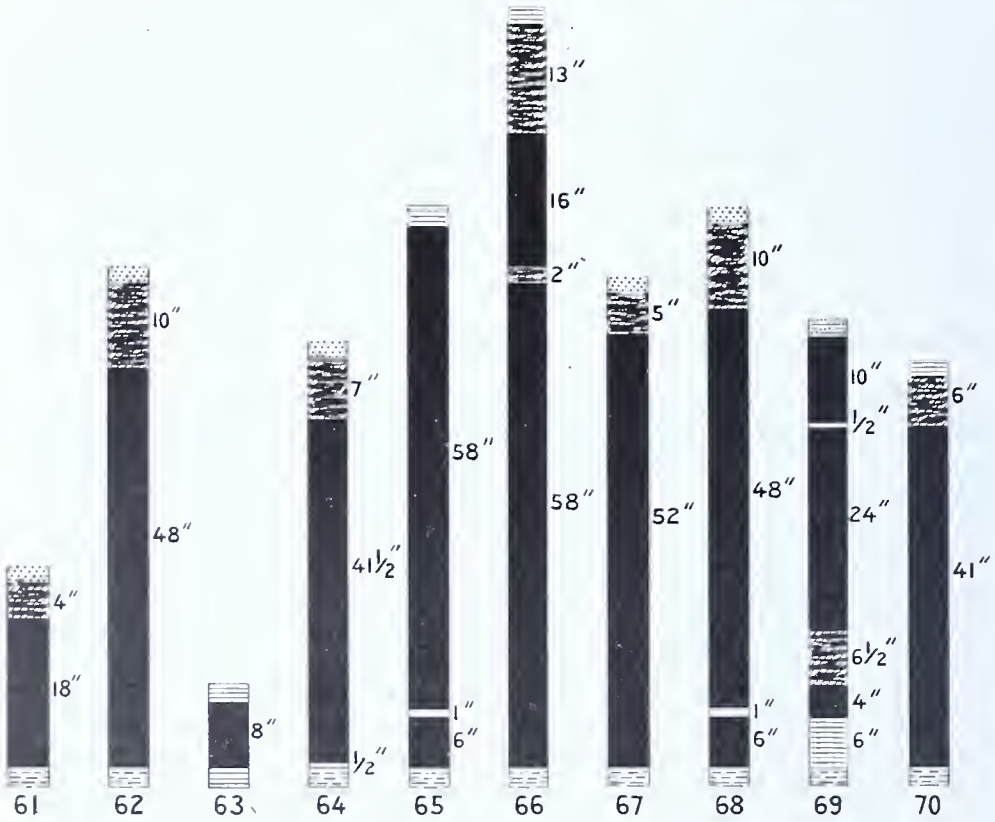


Figure 56. Sections of Upper Freeport coal.

61. Diamond drill hole No. 88. 62. Ce2, 3, Rossmoyne mine. 63. Diamond drill hole No. 90. 64. Diamond drill hole No. 108. 65. Diamond drill hole No. 110. 66. Diamond drill hole No. 111. 67. Diamond drill hole on Stuchel farm about 0.7 of a mile northwest of Plumville. 68. Be5, Ben Raven No. 1 mine. 69. Diamond drill hole No. 102. 70. Diamond drill hole No. 103.

its thickness and cutting it out at many places in the mine. Clay veins are also very numerous. Where the normal thickness of the coal has been preserved, it is 48 inches and is topped by up to 10 inches of bony, which parts free from the roof and the coal and is easily cleaned by hand. The coal has a bright luster, is medium hard, has a blocky fracture, mining out in 40 percent lump, 25 percent not in lump, and 35 percent slack. An average thickness of three feet of clay underlies the coal. A normal section of the coal is shown graphically on figure 56, section 62.

The Upper Freeport had been taken out for domestic use in a country bank (Cd25) on the Elkins farm, about 0.3 of a mile northwest of the Rossmoyne mine, where it was reported to be 48 inches thick and very irregular. Two caved banks on the same coal were observed a little to the northwest of the Elkins bank; the one on the Smith farm (Cd23) was said to have found 36 inches of Upper Freeport coal, but in the other bank, which is on the Hoover farm (Cd21), the thickness of the coal was not known. The Upper Freeport makes a thin bloom (Cd16) on the road just north of the Hoover bank and 6 inches of shaly coal crops out (Cd20) on the road that ascends the hill south of the Hoover bank.

The Upper Freeport horizon is marked by a thin bloom at two places near Rossmoyne (Ce4, De4); also in the shallow railroad cut at Frantz (De1), on the road that ascends the hill east of McCormick (Dd15), and in the lane about 0.6 of a mile north of McCormick (Dd13). The coal and limestone are well exposed in the railroad cut 0.8 of a mile northwest of Trade City Station (Dd2), where the coal is 4½ inches thick (fig. 55, sec. 45). The coal appears as a bloom half a mile eastward along the railroad (Dd3). The Upper Freeport is exposed and is 6½ inches thick in the railroad cut 0.4 of a mile southeast of Trade City Station (Ed3). See figure 55, section 46. Blooms of the coal were seen a little farther eastward on the road north of Mudlick Run (Ed4, 6) and on the highway just north of Trade City Station (Ed2).

A diamond drill hole located 1,000 feet south of Trade City (D.D. hole No. 73) disclosed 4 inches of bony Upper Freeport (fig. 55, sec. 43); and another diamond drill hole half a mile southeast of Trade City (D.D. hole No. 74) found the coal to be 10 inches thick (fig. 55, sec. 44). A few thin blooms of Upper Freeport occur on the south side of Little Mahoning Creek, opposite Trade City Station (Dd8, 9, 10). The Upper Freeport apparently is entirely absent southeastward along the valley of Little Mahoning Creek to where Route 119 crosses the stream; here it appears on the road as a bloom just north of the bridge (Ee17); and on the point of the hill a little to the northwest, a drift had been opened on the Simpson farm (Ee16) where the coal was reported as being 28 inches thick. Along the Baltimore & Ohio Railroad, where it turns south from Little Mahoning Creek toward Oak Tree, the Upper Freeport (Ee18) consists of 13 inches of bony overlain by dark shale containing iron carbonate concretions. On Route 230 east from Route 119, the Upper Freeport horizon was noted as a bloom.

Marion Center District

The Marion Center district is in the southeast corner of the Smicksburg quadrangle and extends roughly south, east, and northeast of Marion Center to just beyond Little Mahoning Creek at the eastern boundary of the quadrangle. The Upper Freeport coal is generally thin or nonexistent in this district and minable Upper Freeport occurs in only a few detached areas comprising about 500 acres, wherein there was an original uneroded deposit of approximately 3,700,000 tons of coal. The Richmond anticline has elevated the horizon of the Upper Freeport from just above drainage or about 1,230 feet above sea level at Oak Tree to a little over 1,750 feet on the axis of the anticline where it leaves the quadrangle, or a difference in elevation of about 500 feet.

The Upper Freeport coal had been opened on the Work farm in the valley of Little Mahoning Creek, on the north side of Route 236, about 1.2 miles from the eastern boundary of the quadrangle (Fe9). The coal was 18 inches thick, overlain by black fissile shale, and with light plastic underclay (fig. 62, sec. 106). Light plastic clay marks the Upper Freeport horizon at a point half a mile up the run immediately to the east (Fe2). A small country bank 0.8 of a mile up the next run to the east is on the Morrow farm (Fe3). The opening was caved and nothing could be learned about the coal.

The Penn-Troy No. 1 mine of the Penn-Troy Coal Company of Johnstown, Pa., is near the point of the hill on the north side of Little Mahoning Creek about 1,000 feet from the eastern border of the quadrangle (Fe6). It was a small pick mine and reportedly active during 1922 and 1923, producing a total of about 2,700 tons of Upper Freeport coal. The bed in this mine has an average thickness of 30 inches, but is very irregular, ranging from 24 to 36 inches. The coal also was reported as being very clean, and having a dull-black luster, medium hardness, rough fracture, and breaks out into about 40 percent lump. The immediate roof of the mine is shale from 5 to 8 feet thick that parts smoothly from the coal. Mahoning sandstone is the cap rock. It is coarse-grained and 10 to 20 feet thick. The section shown on figure 62, section 107 was measured a short distance in the main heading.

The Savan Collieries Company of Indiana, Pa., operated a fairly large pick and machine mine (Fe15, 21) on the Upper Freeport coal in the hill on the south side of Little Mahoning Creek, opposite the Penn-Troy mine. Reports indicate that this mine was practically in continuous operation from 1912 to 1929, producing a total of a little over 500,000 tons of coal. The average daily output was about 250 tons and the peak production of 90,000 was attained in 1925. Reports also indicate that the recoverable coal in this mine is exhausted. The coal is very clean, also very irregular. The average thickness is 41 inches. From 5 to 18 feet of black shale tops the coal, and parts smoothly. The Mahoning sandstone, 10 to 22 feet thick and coarse-grained, is the cap rock. Plastic clay 2 to 7 feet thick makes the floor. The luster of the coal is bright, the hardness medium, and the fracture rough. See figure 62, sections 108, 109.

The Upper Freeport coal apparently had been found in a prospect pit (Fe13) in the hillside above the creek, west of the Savan mine. Up the run immediately to the west, an abandoned country bank gave evidence that a considerable amount of Upper Freeport coal had been removed (Fe23). In the small ravine about 0.4 of a mile southeast of the above bank, a small drift had at one time been opened on the same coal bed (Fe27). It appears that the above mentioned run marks the western limit and the road running over the divide eastward from B.M. 1332 roughly marks the southern limit of minable Upper Freeport in the locality described above. From direct and indirect information, it seems that workable Upper Freeport coal is doubtfully present in the remaining part of this district, excepting a few minor local occurrences.

A patch of approximately 12.8 acres in the hilltop on the eastern border of the quadrangle north of the head of Pickering Run, probably contains Upper Freeport of workable thickness because the coal had been mined in a drift in the same hilltop in the Punxsutawney quadrangle. About 32 acres of Upper Freeport is in the hilltop south of Pickering Run on the Campbell land where the coal had been opened at two places in this quadrangle (Ef18, 19). In the former bank, the reported section of the bed is in descending order as follows; shale; rider coal, 1 inch; bony, 4½ inches; coal, 36 inches; clay. See also figure 62, section 110.

Thin blooms of Upper Freeport coal occur along the improved road eastward toward Marion Center (Ff20, 14), also southeast (Ff27) and south of Marion Center (Ff23). On the Park farm, about 0.8 of a mile north of Marion Center (Ef4) a prospect pit on the outcrop of the Upper Freeport apparently found some coal, but the thickness could not be determined. A bloom of Upper Freeport was observed above the road just off Route 119, west of Marion Center (Ef5).

Southwest of Marion Center, along Route 119, the Upper Freeport is developed to a workable thickness, which probably is only local, and has been mined for domestic use by the residents. All these workings were closed when this locality was investigated, consequently information about the nature of the coal was obtained indirectly. On the Lightcap farm (Ef27), the bed is 15 inches thick, is overlain by shale, and underlain by clay (fig. 62, sec. 105). The coal was 36 inches thick in a drift on the Whiteacre farm to the south (Ef30). It is topped by 4 inches of bony, which is overlain by dark shale containing siderite concretions; the mine is floored by clay (fig. 62, sec. 104). Another drift on the Upper Freeport a little farther south, also on the Whiteacre farm but just off the Smicksburg quadrangle, disclosed that the coal is 30 inches thick, having 8 inches of bony on top, which in turn, is overlain by dark shale with siderite concretions (fig. 62, sec. 103.) Still farther south in a drift on the Thompson farm, the Upper Freeport coal is 26 inches thick, with five inches of bony on top. The roof is shale and the floor is clay (fig. 62, sec. 102).

The Upper Freeport had been worked at two places on the east side of Pine Run in Rayne Township (Ef31, 32), but the exact thickness of the coal in those banks was not known.

Sagamore District

The Sagamore district is in the southwestern part of the Smicksburg quadrangle. It includes the area surrounding the mining town of Sagamore and the village of Plumville that is underlain by Upper Freeport coal having a minable thickness. Structurally, the district lies at the southwestern end of the plunging axis of the Plumville anticline, which locally is like a warped surface having a regional southwest dip. The outcrop of the Upper Freeport is just above North Branch Plum Creek from Sagamore to near Plumville, a distance of a little over two miles. An excellent exposure of the coal may be seen at the road corner west of Beyer on Route 85 (Bf1).

Figure 57. Mahoning sandstone, Upper Freeport coal and underclay, northeast of Sagamore.

The coal has a thick and widespread development in this district. The known maximum thickness is a little over 80 inches and minable

coal in the quadrangle underlies approximately 3,200 acres. However, large scale commercial operations have been carried on for many years and the economically minable coal within the quadrangle is nearly depleted.

The Buffalo & Susquehanna Coal & Coke Company of DuBois opened their Sagamore mines and began shipping coal in 1905. At that time those mines were equipped with one of the largest steel tipples, power and compressor plants in the Bituminous Field. Electric power operated the chain hoists on the tipple, the locomotives, fans, and compressors. The compressors operated the cutting machines and pumps in the mines. The daily capacity was 10,000 tons. The Sagamore mines operated almost continuously up to and including 1944. The initial production in 1905 was 5,800 tons. The peak yearly production was reached in 1913 when 1,688,000 tons were shipped to markets. The total production up to and including 1943, was more than 22,000,000 tons, or over one-third of all coal mined commercially in the quadrangle. The coal was worked in eight drift entries numbered 11 to 18. Some of these entries eventually were abandoned because, as the workings advanced, it was found advantageous to work the coal through adjacent mines. Only two entries were being used in 1944.

The Sagamore No. 11 mine is situated on the north side of North Branch Plum Creek, about 1.4 miles northeast of Sagamore Station (Bf2). The entry was abandoned about 1912 and the remaining coal acreage was worked through other mines of the company. The coal in this mine has an average thickness of 60 inches, but contains numer-

Figure 58. Buffalo & Susquehanna Coal and Coke Co. mines at Sagamore.

ous impurities, consisting of bone coal, slate, and sulphur. Mahoning sandstone is the cap rock, shale is the immediate roof, and 2 to 3 feet of clay makes the floor. A representative section of the coal in this mine is shown on figure 59, section 76. On the south side

of the creek, opposite No. 11 mine, is No. 12 mine (Af15). This drift also was abandoned about 1912 and the remaining coal was extracted through other mines. The coal averages 60 inches thick and is very dirty. A fair average section in this mine is shown on figure 60, section 90.

Sagamore No. 13 mine is on the north side of the creek about 0.8 of a mile northeast of Sagamore Station (Af4). Coal was being removed through this mine as late as 1944. The bed is irregular and faulty. Where the coal has its normal thickness of 48 inches, it tends to be rather free from impurities and has its characteristic bony on top. Where the bed has an abnormal thickness, which at some places is up to 74 inches, it commonly contains numerous partings and binders that are difficult to clean, in particular, there is up to 17 inches of bone coal about 48 inches from the bottom. Sulphur bands and nodules are scattered throughout. Coal in the upper bench is dull, in the lower bench bright. Shale or sandstone is in contact at the top and 2 to 3 feet of clay makes the floor. The coal breaks out into 50 percent large-size lump, 20 percent not in lump, and 30 percent slack. The recovery is 90 percent. An average daily output of

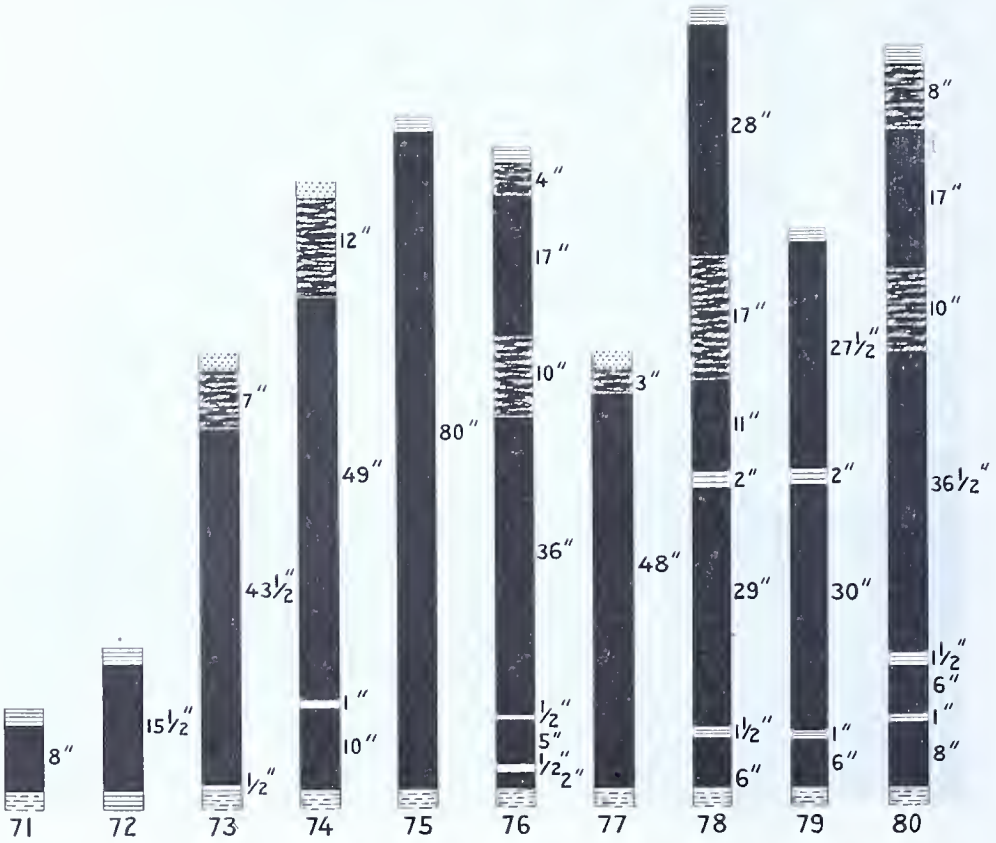


Figure 59. Sections of Upper Freeport coal.

71. Diamond drill hole No. 104. 72. Diamond drill hole No. 105. 73. Diamond drill hole No. 106. 74. Bf3, Butler mine. 75. Diamond drill hole No. 109. 76. Bf2, Sagamore mine No. 11. 77. Diamond drill hole No. 113. 78. Af4, Sagamore mine No. 13. 79. Af5, Sagamore mine No. 13. 80. Af6, Sagamore mine No. 15.

1,200 tons was indicated as the capacity of this mine. The section shown on figure 59, section 78 was measured at 1st left, off 1B, off 26 left.

The entry on No. 14 mine (Af5) is on the south side of the creek directly opposite No. 13. This drift was abandoned in 1911 and the coal was being worked through other mines. An average section of the coal is shown on figure 60, section 89. The entry to Sagamore No. 15 mine is located on the north side of the creek about 0.4 of a mile northeast of Sagamore (Af6). The Upper Freeport is irregular and cut out by sandstone at some places in these workings. For the first 400 feet in from the drift mouth, the coal was soft and ranged from 24 to 72 inches thick. The normal thickness of the coal is 48 inches and the character of the bed and associated strata is generally similar to that in No. 13 mine (fig. 59, sec. 80). This mine had an average daily output of 600 tons. The recovery was 90 percent. The entry to this mine is no longer in use. No. 16 mine (Af7) which is opposite No. 15, was discontinued in 1919 and the remaining coal was removed through other mines. However, this drift was later reopened and coal was being removed from the mine in 1941. A typical section of the bed as it occurs in the mine is shown on figure 60, section 87.

Sagamore No. 17 is on the north side of the creek at the town. The drift mouth was not in use in 1944 and apparently had not been for some years. The coal is moderately soft 100 feet in from the outcrop. Rock rolls and faults were encountered in this mine. Normally the bed is 4 feet thick, has a bright luster, and is medium hard. The roof is shale and the underclay is 2 to 3 feet thick. The coal tends to become dirtier in proportion to its thickness, which impurities consist of bone, slate, and sulphur. The section shown on figure 60, section 84 is typical and was obtained 7,000 feet from drift entrance, 12 room off C heading off 28 left. An analysis of a sample from this mine indicated 7.9 percent ash and 2.3 percent sulphur (see table 2). The coal broke in 40 percent lump, 30 percent not in lump, and 30 percent slack. The recovery was 90 percent and the daily average output of the mine was 1,000 tons.

The entry to No. 18 mine is on the south side of the creek, opposite Sagamore (Af8). The drift to this mine is abandoned. It was reported that the coal bed is very irregular, being affected by "rolls" and faults. At some places the coal is very clean, whereas at others it is exceedingly dirty. The reported average thickness is 48 inches with a variable thickness of bony on top; and where abnormally thick, the impurities increase. The bed is split into two benches by the bone coal parting four feet from the bottom; the upper bench has a dull luster and the lower a bright luster. A section measured at face off room 28 left 8,100 feet from drift entrance is shown on figure 61, section 93. The coal is soft 50 feet in from the outcrop and from thereon is medium hard. The mine is roofed by either shale or sandstone and 2 to 5 feet of clay is under the coal. The coal mined out in 40 percent lump, 30 percent not in lump, and 30 percent slack. A 90 percent recovery is indicated; also, an average daily output of 700 tons.

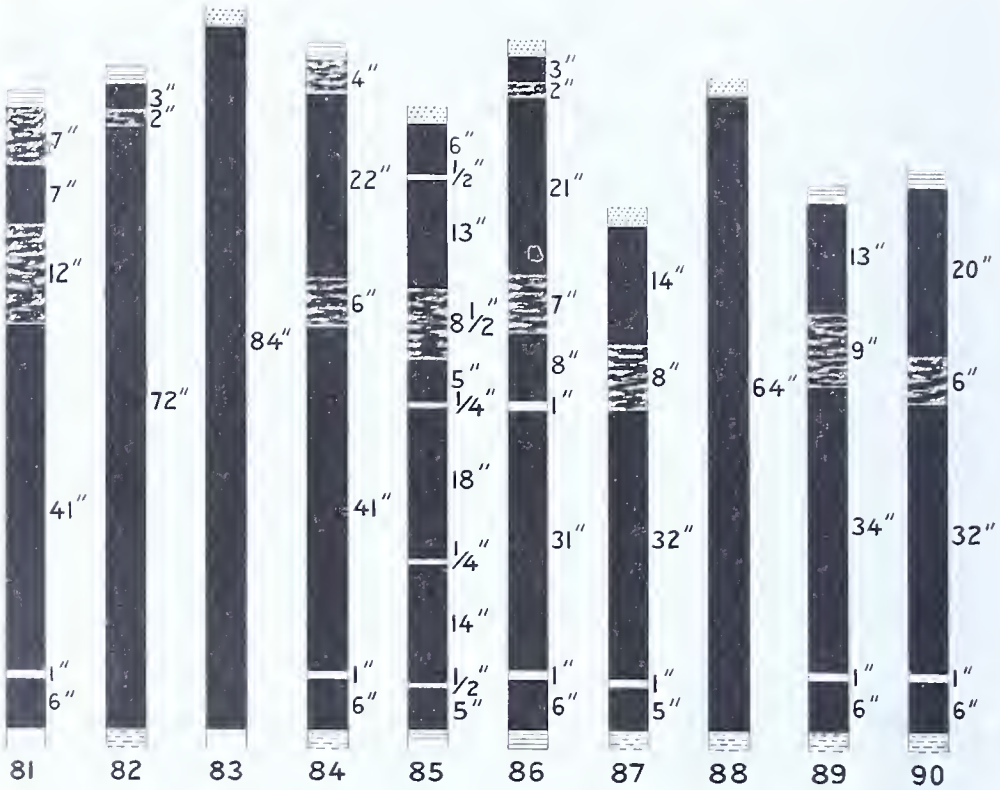


Figure 60. Sections of Upper Freeport coal.

81. Af6, Sagamore mine No. 15. 82. Diamond drill hole No. 112. 83. Diamond drill hole No. 119. 84. Sagamore mine No. 17. 85. Sagamore mine No. 17. 86. Sagamore mine No. 17. 87. Af7, Sagamore mine No. 16. 88. Diamond drill hole No. 118. 89. Af5, Sagamore mine No. 14. 90. Af15, Sagamore mine No. 12.

The McCreight mine, which was operated by the Kurtz Coal Co. of Indiana, is located just a little northeast of Sagamore No. 13. This mine worked the Upper Freeport during the early 1920's. At an average daily output of 200 tons, the lifetime of the mine was estimated to be 15 years, but the project was discontinued before the coal was exhausted. An average thickness of 54 inches for the coal was reported; bone coal from 6 to 11 inches thick occurs near the top. This is easily separated by the miner. Sandstone is the cap rock and shale 3 to 8 feet thick is the immediate roof. The coal mined out in 50 percent lump, 25 percent nut size, and 25 percent slack. About 200 tons was the average daily output, and the recovery was 85 to 90 percent.

The Atwood Slope mine of the Atwood Coal Co. of Pitcairn, Pa., is situated about 1.2 miles southwest of Sagamore Station (Af10). This mine was worked from 1924 to 1930 and produced approximately 30,000 tons of Upper Freeport coal. The bed is up to 80 inches thick and is separated near the middle by a slaty parting about 14 inches thick. Sulphur bands and nodules are scattered throughout the coal. Mahoning sandstone approximately 40 feet thick is the cap rock and

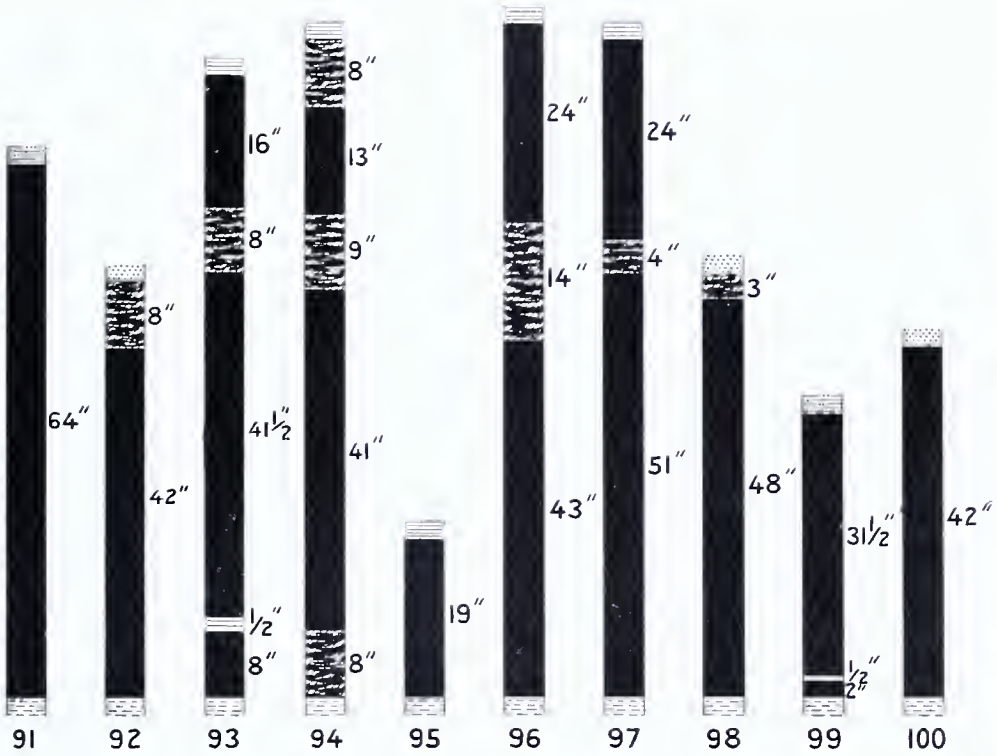


Figure 61. Sections of Upper Freeport coal.

91. Diamond drill hole No. 116. 92. Diamond drill hole No. 120. 93. Af8, Sagamore mine No. 18. 94. Af8, Sagamore mine No. 18. 95. Diamond drill hole No. 121. 96. Af10, Atwood mine. 97. Diamond drill hole No. 123. 98. Diamond drill hole No. 122. 99. Diamond drill hole No. 126. 100. Diamond drill hole No. 124.

the immediate roof is shale up to 15 feet thick. The coal is underlain by 5 feet of clay. The section shown on figure 61, section 96 was measured near the foot of the slope on the main heading.

Plumville. Two commercial mines worked the Upper Freeport at Plumville. The coal is below drainage at that place, and it was, therefore, entered in slopes. The Butler mine of the Consolidated Coal & Coke Co., with headquarters at Butler, is located on the south side of North Branch Plum Creek (Bf3). This mine was opened in 1918 and abandoned in 1934, being idle in 1925, 1931, and 1933. It was equipped with mining machinery, and electric power was developed at the mine. About 150 tons was the average daily output and the total production from the mine is something over 600,000 tons. The normal thickness of the seam is indicated as 60 inches, but it is very irregular, faults at numerous places necessitated a deviation from the common room and pillar system of mining. Mahoning sandstone up to 30 feet thick is the roof. About 12 inches of bone, which is "burned" to the roof, is immediately in contact with the coal where normal. A persistent binder one to two inches thick occurs 10 inches from the bottom and sulphur is scattered throughout. Clay averaging 5 feet thick is everywhere under the coal. The coal has a bright luster,

is medium hard, and has a columnar block fracture, mining out in 40 percent fair-sized lump, 25 percent not in lump, and 35 percent slack. Section 74, shown on figure 59, was measured 1,000 feet in main heading.

On the north side of the creek about 0.3 of a mile northeast of the Butler slope, a smaller mine that had an average daily output of about 60 tons, was operated by Sutter-Rinn Coal Co. of Indiana and is called the Ben Raven No. 1 (Be5). This mine was active from 1918 through 1924 and produced more than 60,000 tons. The normal thickness of the coal is indicated as 48 inches, and it is fairly clean. However, irregular and faulty conditions are prevalent in this mine. Where unaffected by "rock rolls" and "faults," the seam carries about 10 inches of bone which parts easily from the coal and was picked by hand. About 25 feet of hard, massive Mahoning sandstone makes the cap rock and roof. The bone parting near the bottom is also persistent in this mine. Soft clay having an average thickness of 2 feet underlies the coal (see fig. 56, sec. 68). The coal is bright, medium hard, and has a columnar block fracture, breaking out in 40 percent large-size lump, 30 percent not in lump, and 30 percent slack. The recovery was about 80 percent.

Mining operations on the Upper Freeport coal in the Sagamore district have been extended westward into the Rural Valley quadrangle in the area north of North Branch Plum Creek, north nearly

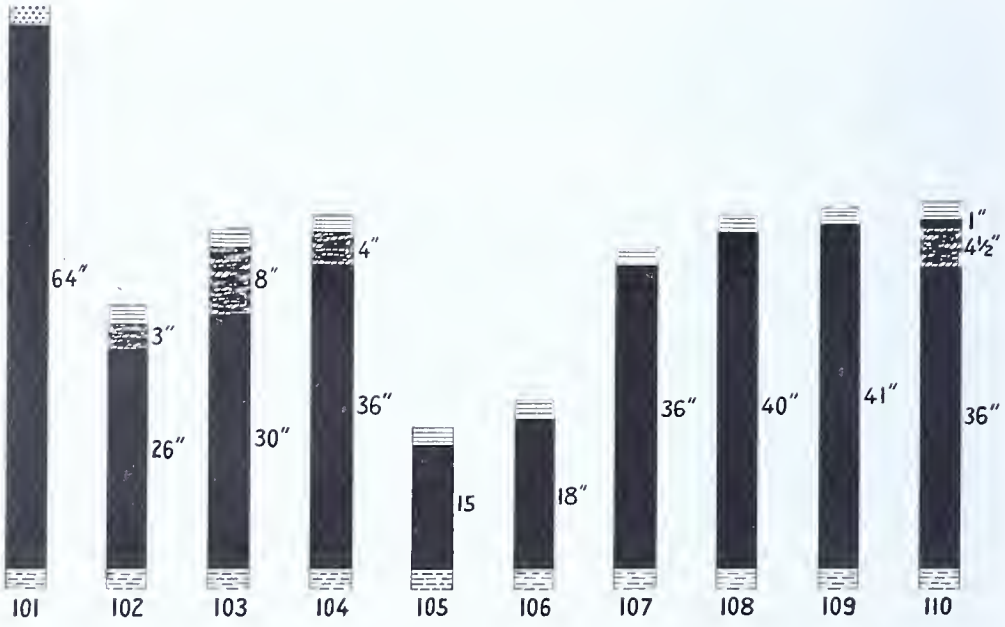


Figure 62. Sections of Upper Freeport coal.

101. Diamond drill hole No. 125. 102. Country bank, Thompson farm, about 2.5 miles southwest of Marion Center. 103. Country bank, Whiteacre farm, about 2 miles southwest of Marion Center. 104. Ef30, country bank, Whiteacre farm. 105. Ef27, country bank, Lightcap farm. 106. Fe9, country bank, Work farm. 107. Fe6, Penn-Troy No. 1 mine. 108. Fe15, Savan No. 1 mine. 109. Fe15, Savan No. 1 mine. 110. Ff18, country bank, Campbell farm.

to Cowanshannock Creek, about 2 miles east of Hossick Mill, around Plumville, southeast of Sagamore to near Sugar Camp Run, and at least 3.4 miles south of the extreme southwest end of Sagamore.

Sagamore District Extended

The horizon of the Upper Freeport underlies a very large area in the Smicksburg quadrangle outside the approximate limit of workable coal in the Sagamore district. Core drilling in the outlying area was reported, but direct information was not available. Information obtained from sources of questionable authority indicates that those explorations were generally unfavorable. However, a few widely spaced tests that show the coal to be missing or too thin to have economic value, should not absolutely condemn an area as a whole. It is not improbable that intensive exploration may disclose Upper Freeport having minable thickness and under acreage large enough to constitute a potential reserve.

Where a core reveals thin Upper Freeport with bony at the top, it would be reasonable to assume that the indicated thickness of the coal is original and would, to some extent, reflect the nature of the bed in that locality. However, if a test shows thin coal having sandstone in contact at the top, it is quite likely that the original thickness of the bed had been reduced by erosion. This may be only a local condition and near-by coal not similarly affected would have a minable thickness.

The limit of minable Upper Freeport coal within the Smicksburg quadrangle in the Sagamore district was determined on the basis of a few scattered diamond core drill holes. The boundary line is irregular in outline (see fig. 50) and is drawn by inference beyond the marginal holes showing coal of minable thickness, and inside the holes where the Upper Freeport is thin or lacking.

Near the mouth of Spruce Run, about one mile southwest of Barnards, a diamond core drill hole (96) disclosed 62 inches of Upper Freeport coal (fig. 55, sec. 55); about 0.6 of a mile farther north along Spruce Run, a core in another hole (95) shows the same coal had thinned to 19 inches (fig. 55, sec. 52); and near the head of Spruce Run a core of Upper Freeport taken on the Burns farm (80) is 39 inches thick (fig. 55, sec. 47). North of Barnards on the Calvert farm (94), a core of Upper Freeport measured 45 inches (fig. 55, sec. 51). Below Barnards on the south side of Cowanshannock Creek, a core drill prospect on the Doutts farm (95a) showed only 12 inches of Upper Freeport (fig. 55, sec. 53), but about half a mile to the southeast a diamond drill hole on the Barnard farm (93) found the coal to be 52 inches thick (fig. 55, sec. 54).

Two holes were drilled about 1.1 miles northeast of Barnards; the one on the Barnard farm (81) showed 7 inches of coal (fig. 55, sec. 48) whereas the hole 0.2 of a mile southeast from there on the Neigh farm (82) revealed 32 inches of Upper Freeport coal (fig. 55, sec. 49). About 1.3 miles northeast of Barnards, a core drill hole on the Marshall farm (83) found only 24 inches of Upper Freeport coal (fig. 55, sec. 50). On the Rowland farm, one mile northwest of Denton, where a core drill test was made (85), the Upper Freeport

coal is missing and its place is occupied by shale (fig. 14, sec. 36). It is 52 inches thick (fig. 55, sec. 58) in a drill hole put down on the Rairie farm 1.6 miles northeast of Hoosicks Mill (99). On the Lowry farm, about one mile to the northeast (92) the Upper Freeport is represented by six inches of bony. Three-tenths of a mile southeast of Denton, a diamond drill hole on the Marshall farm (86) revealed only 15 inches of coal at the Upper Freeport horizon (fig. 55, sec. 59).

On the Good farm, about 1.3 miles east of Denton, a core drill test (87) found 8 inches of Upper Freeport (fig. 55, sec. 60.) On the Mogle farm, 0.3 of a mile southeast from there (88), the coal is 18 inches thick (fig. 56, sec. 61.) On the Davis farm, 0.7 of a mile southwest of Rossmoyne (90), a core showed only 8 inches of the same coal. The Upper Freeport was missing in a diamond drill hole put down on the Neff farm (101), 1.4 miles southeast of Rossmoyne. On the Heberling farm, 0.7 of a mile northeast of East Plumville (102), a core showed a net thickness of 38 inches of Upper Freeport coal (fig. 56, sec. 69); and on the Davis farm, 0.4 of a mile to the south (103), 41 inches of coal was encountered in a drill hole (fig. 56, sec. 70). The Upper Freeport was cored on the Weaver farm (104), 0.7 of a mile east of the latter place, revealing only 8 inches of coal (fig. 59, sec. 71); and 0.4 of a mile southeast of Plumville, on another Weaver farm (105), the core drill found 15½ inches of Upper Freeport coal (fig. 59, sec. 72).

The Upper Freeport was drilled on the Tucker farm about 0.6 of a mile north of Plumville (107) and the result shows that the coal horizon is marked by three inches of bone and coal. A diamond drill hole on the Thompson farm, 0.8 of a mile north of Plumville (108), produced a core containing 41½ inches of coal (fig. 56, sec. 64). On the Beltz land in Plumville (106), a core showed the Upper Freeport had a thickness of 43½ inches (fig. 59, sec. 73); and about half a mile south from there on the Stewart farm (114), a core consisted of sandstone, 13 inches of coal and bone, and clay.

Two miles southeast of Sagamore a core drill test of the Upper Freeport on the Allshouse farm (125) disclosed the coal to be 64 inches thick (fig. 62, sec. 101). On the Weamer farm, about 0.6 of a mile east from there (124), the same coal is 42 inches thick (fig. 61, sec. 100); and in a drill hole 1.7 miles south of Sagamore (126), the Upper Freeport has a thickness of 33½ inches (fig. 61, sec. 99). The results of diamond core drilling elsewhere in the Sagamore district are shown on figure 55, sections 56, 57; figure 56, sections 65, 66, 67; figure 59, sections 75, 77; figure 60, sections 82, 83, 88, and figure 61, sections 91, 92, 95, 97, 98.

LOWER FREEPORT COAL

The horizon of the Lower Freeport covers approximately 171.8 square miles of the Smicksburg quadrangle. About 42 square miles was underlain by an original deposit of workable coal which is estimated to be approximately 1,481,979,000 tons; and about 19.4 square miles is underlain by coal that probably has a workable thickness and estimated to be approximately 169,624,000 tons, less an unknown quantity of coal that has been removed. The minimum reported total

Figure 63. Map showing general distribution and thickness of the Lower Freeport coal.

of Lower Freeport produced commercially in the quadrangle up to and including 1943 is something over 15,000,000 tons, plus an estimated 5,250,000 tons unrecoverable in mining or about 20,250,000 tons mined and lost.

Although an estimate of the net reserves based on the above figures would appear to exceed greatly the tonnage already removed, the survey of the field reveals that most of the thicker and better quality coal has been worked out. Also, the tonnage estimated for the aggregate areas containing Lower Freeport of probable economic value was calculated from average thickness of a relatively few measured sections of the coal bed. Furthermore, in the latter areas, the coal is erratic in occurrence. The general distribution of Lower Freeport coal is shown on figure 63.

The overall average thickness of the Lower Freeport is 33 inches. Its known maximum thickness is 120 inches. One or more rider coals are present locally. Impurities such as slaty or bone binders and partings are present but not persistent, and bands and balls of sulphur are common. The Butler sandstone "rolls" into and through the coal at some places, but those conditions apparently are less frequent than in the Upper Freeport. Clay squeezes are numerous and render an appreciable amount of coal unrecoverable and a variable amount of shaly cannel coal at the top characterizes the bed in some localities. It is an established criterion among coal operators and mining engineers in the region that where the interval from the Upper Freeport horizon to the Lower Freeport is greater, the Lower Freeport may be expected to be well developed; apparently that rule applies in the Smicksburg quadrangle.

The Lower Freeport is generally better in quality than the Upper Freeport. The average of available analyses is as follows: moisture, 2.14 percent; volatile matter, 32.97; fixed carbon, 57.39; ash, 7.12; sulphur, 1.3, and b.t.u. as received, 13723.

The following detailed description of the Lower Freeport coal concerns four districts in the Smicksburg quadrangle. They are: Frostburg-Hamilton district in the northeast, Pine Run district in the northwest, North Point-Smicksburg district in the central part, and Marion Center district in the southeast.

Frostburg-Hamilton District

The Frostburg-Hamilton district comprises the area in the quadrangle drained by Big Run and its tributaries and by Mahoning Creek and its tributaries westward to near North Point. The district is the southwestern end of the Reynoldsville-Punxsutawney coal field, which was one of the largest in the State and because of its location has been a large source of supply to New York and New England States.

Being confined within the axes of the Sprankle Mills anticline and the Punxsutawney syncline, the structure in this district is essentially monoclinal. The dip is rather gentle in the upland southeastward from the Sprankle Mills anticline to near Mahoning Creek, where from Hamilton northeastward, the dip becomes very strong as

the axis of the Punxsutawney syncline is approached. The Lower Freeport coal horizon, therefore, rises from below drainage, or about 1,100 feet above sea level at the lowest point on the axis of the Punxsutawney syncline, to an elevation of a little above 1,700 feet northwest of Grange, making a difference in elevation of 600 feet. In the Big Run area north of Grange, the upper part of the Allegheny group has been eroded; and in the area north of Frostburg the Lower Freeport occurs in detached areas in the upland.

The Lower Freeport coal is generally of excellent quality and its best and most persistent development in the quadrangle is in this district. Its coking qualities are also noteworthy. Numerous relatively large commercial mines and small custom and country banks have exploited the coal for many years and beginning in 1941, stripping operations were recovering large tonnages of crop coal. Consequently, the Lower Freeport is rapidly reaching the point of exhaustion.

Eureka mines. Although coal had been mined commercially in the quadrangle through the Walston mines in the Punxsutawney quadrangle, which were opened in the early 1880's the first commercial mines in the quadrangle were started in 1887 by the Berwind-White Coal Company. These mines were situated along Mahoning Creek and were called West Eureka Nos. 1 to 7. The Lower Freeport in these mines was about worked out by 1908, and they were abandoned by the operating company. From that time some of them were worked mostly for pillar coal by local companies. The reported total production of coal from these mines up to and including 1908 is something over 8,000,000 tons. Other commercial operations soon followed the West Eureka mines and in the early part of the 20th century, this district was very active, but when the field work for this report was begun, only one commercial mine was being worked. Some of these mines have been abandoned so long that by natural concealment and cultural improvements, the entries are no longer recognizable.

The entry to West Eureka No. 5 slope was on the north side of Mahoning Creek at the eastern boundary of the quadrangle. This mine was opened in 1889 and abandoned in 1900. It produced over 850,000 tons. West Eureka No. 1 drift, a little to the west on the same side of the creek (Fb14), was opened in 1887. Pillar pulling began in 1893 and was finished in 1901. The thickness of the Lower Freeport is from 3½ to 7 feet and the total production of coal is about 1,437,000 tons. A heading was driven through to No. 5 in 1892 and some of the coal in that mine was worked through No. 1. Contemporaneous with the opening of West Eureka No. 1, a bank of coke ovens was built near-by.

West Eureka No. 6 is on the south side of Mahoning Creek opposite No. 1 (Fb15). The thickness of the Lower Freeport ranges from 5 to 8 feet. The mine was worked from 1892 to 1908 and produced approximately 1,725,000 tons. A 400-foot slope extended from the surface to the coal bed and double tracks ran along the main heading. This mine is gaseous and bad roof conditions are prevalent, re-

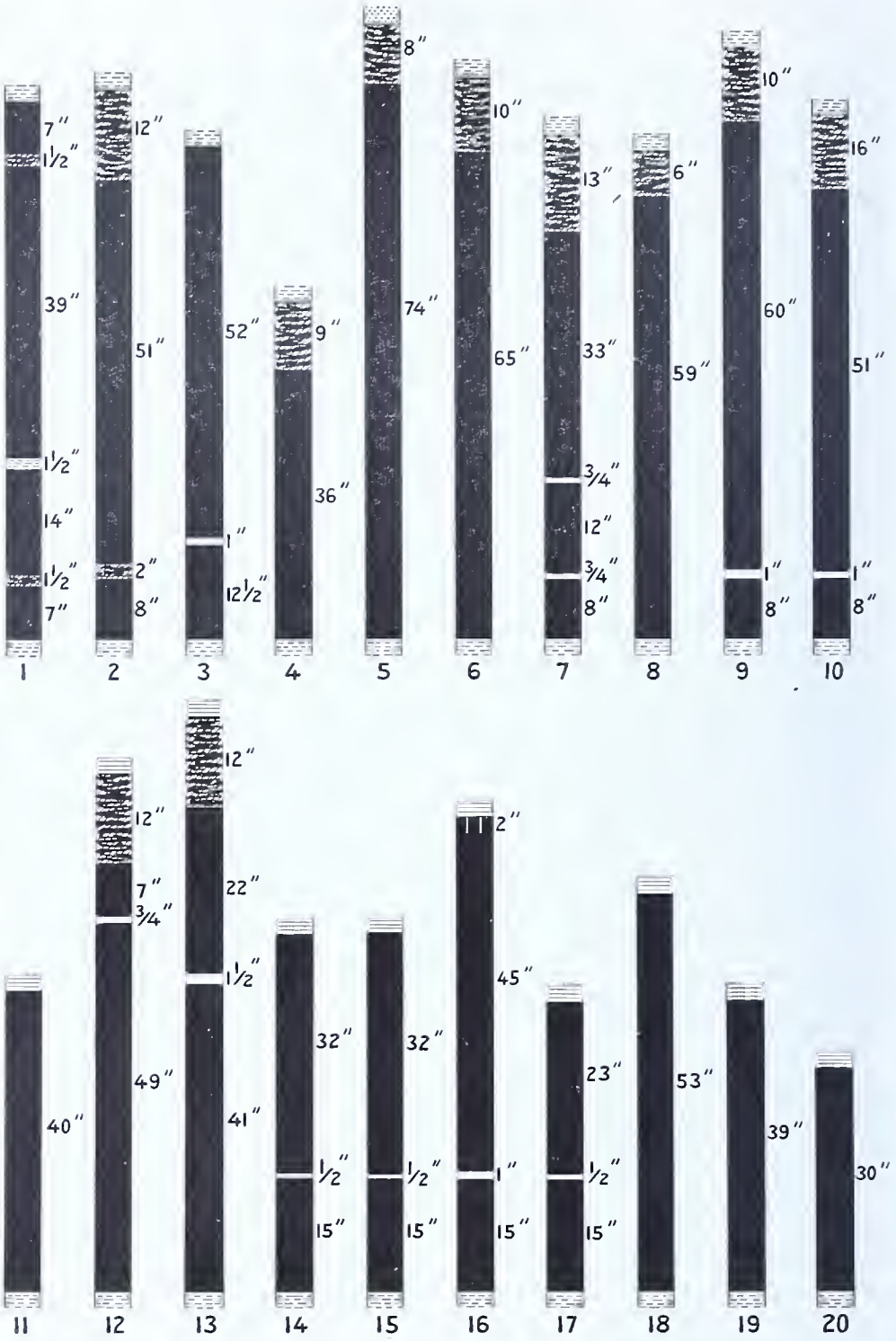


Figure 64. Sections of Lower Freeport coal.

1. Fa5, country bank. 2. Fa8, Smith mine. 3. Fa14, country bank. 4. Fa11, country bank, Caylor farm. 5. Fa18, country bank, McQuown farm. 6. Ea16, stripping, Neal farm. 7. Ea26, country bank, Lewis farm. 8. Ea38, country bank. 9. Ea19, country bank, Means farm. 10. Fa30, Frostburg mine. 11. Fa35, custom bank. 12. Fa25, country bank. 13. Fa26, country bank. 14. Fa39, custom bank, Lewis farm. 15. Fa38, custom bank. 16. Fa45, custom bank, Drummond farm. 17. Fa47, Williams Run No. 8 mine. 18. Ea41, custom bank, Shaffer farm. 19. Ea29, custom bank. 20. Diamond drill hole No. 27.

quiring supports with 12 by 12 inch timbers. A sizeable fault was encountered near the pump shaft, and a disastrous fire occurred in these workings in 1893. Something of the nature of the Lower Freeport on the east side of Mahoning Creek north of Sportsburg is preserved in the records of diamond drill explorations (fig. 67, secs. 42-50, and fig. 68, secs. 51, 52), which show that the coal is exceedingly variable in character and thickness. About 0.6 of a mile south of No. 6 slope, there is evidence that an attempt had been made, or a slope had actually been driven to the Lower Freeport coal, but its history could not be learned.

West Eureka No. 2 is on the north side of Mahoning Creek, half a mile north of Sportsburg (Fb23). This mine was worked from 1888 to 1896, during which time about 1,361,000 tons of coal were removed. The mine was later operated by a local company to remove remaining stumps and pillars. Difficult water conditions and large faults were reported. The coal bed was entered on a 12° slope, 500 feet long.

Numerous openings had been made along the outcrop of the Lower Freeport southwest of West Eureka No. 1 and up the nameless run to the north (Fa45-48, Fb4-13). The Williams Run Coal Company of Punxsutawney worked the coal in eight of these drifts, but the numerical identity of most of these mines is uncertain. Nos. 1 and 2 are presumed to be those near the mouth of the run southwest of West Eureka No. 1. No. 5 is on the west side of the run about 0.4 of a mile from its mouth (Fb12); and No. 7 (Fa46) and No. 8 (Fa47) are at the head of the east fork of the run. Approximately 900,000 tons of coal had been produced by the Williams Run Coal Company from 1914 to 1937. Analyses made from samples of the coal in No. 1 mine show from 4.6 to 5.7 percent ash, and 1.1 percent sulphur (see analyses, table 2). A section of the bed was obtained in the main heading of No. 8, which showed 36 inches of coal having a ½-inch binder 15 inches from the bottom. The roof is black shale and the floor is clay (fig. 64, sec. 17). The face of the coal bears N.65°W. and the butt N.35°E.

A custom bank on the Clark Drummond farm a little to the southeast was being worked (Fa45) and revealed the Lower Freepeort to be 60 inches thick. The binder near the bottom is one inch thick. The coal is topped by two inches of cannel. The roof is shale and the floor of the mine is clay (fig. 64, sec. 16). The face cleat of the coal bears N.55°W. and the butt N.45°E. An analysis of two channel samples showed the ash content to be 7.8 percent and the sulphur 0.72 percent (see complete anlysis, table 3). The outcrop was observed on the road a little to the west (Fb4). Along the road up the west fork of the run, a bloom of the Lower Freeport was also seen (Fb2) and near-by is a caved country bank (Fb3). Custom coal was being mined in a drift a little to the southeast of No. 5 (Fb13) wherein the coal measured 55 inches and is overlain by shale and underlain by clay (fig. 65, sec. 25).

Southwest along the hard surface road on the north side of Mahoning Creek, the Lower Freeport makes a poor outcrop (Fb20) and just below the road in the bank of the creek, there is a caved drift

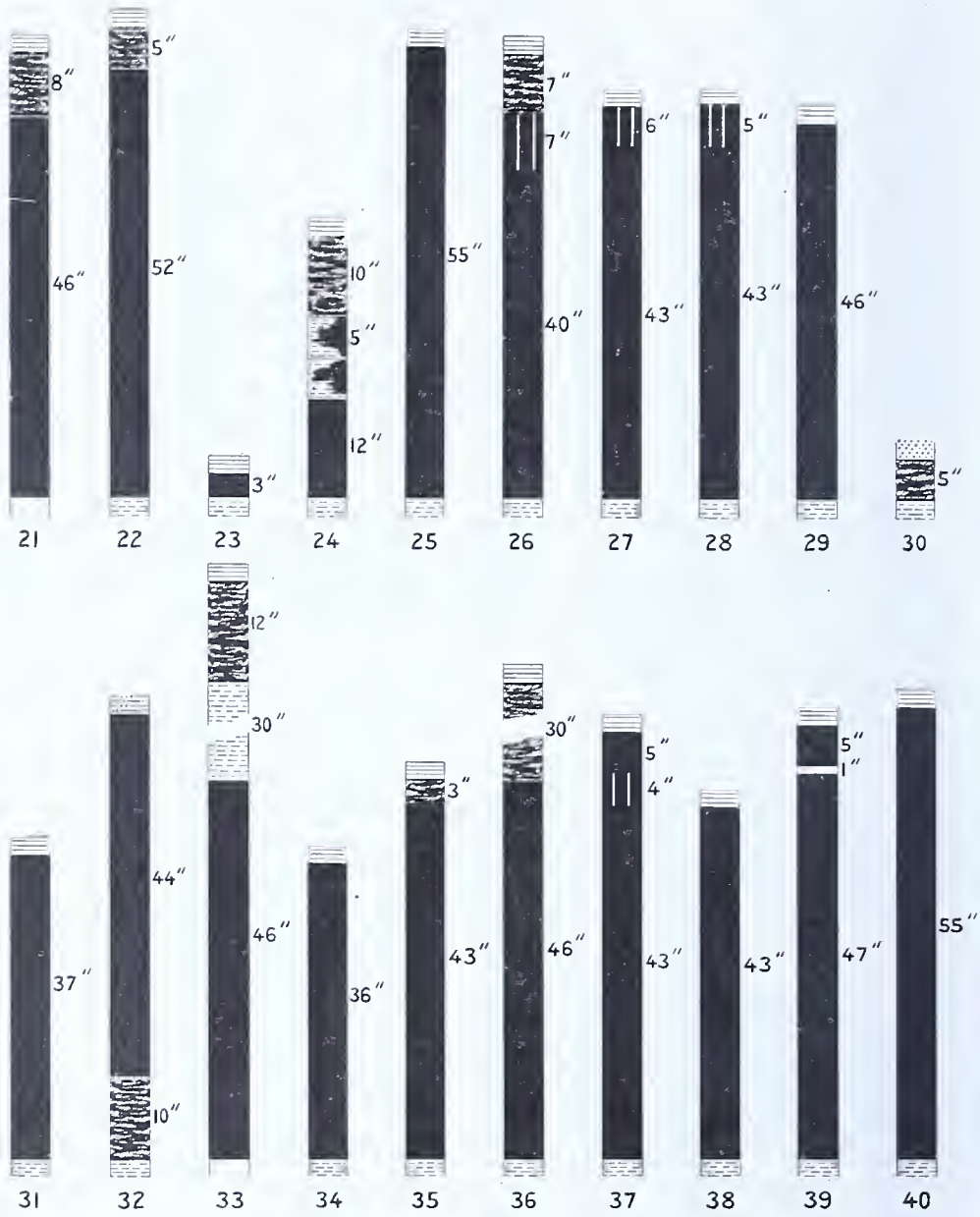


Figure 65. Sections of Lower Freeport coal.

21. Diamond drill hole No. 26. 22. Diamond drill hole No. 28. 23. Diamond drill hole No. 29. 24. Diamond drill hole No. 30. 25. Fb13, custom bank. 26. Diamond drill hole No. 25. 27. Diamond drill hole No. 24. 28. Diamond drill hole No. 19. 29. Eb38, custom bank. 30. Diamond drill hole No. 42. 31. Eb16, country bank, Cook farm. 32. Diamond drill hole No. 16. 33. Eb28, country bank. 34. Eb50, custom bank, Postlewaite farm. 35. Eb48, custom bank, Postlewaite farm. 36. Diamond drill hole No. 20. 37. Eb54, custom bank, Gabrielson farm. 38. Diamond drill hole No. 23. 39. Diamond drill hole No. 22. 40. Fb27, custom bank.

(Fb21). The caved drift of West Eureka No. 3 is on the steep hillside about half a mile to the west (Fb19). Information about this mine is lacking, but apparently it was abandoned soon after it was opened in 1888 since its total reported production is only 728 tons. Diamond core drilling in the area underlain by Lower Freeport to the north, indicates that coal there ranges in thickness from 3 to 52 inches; binders and partings apparently are lacking. Up to 10 inches of bony is over the bed, and one section shows 7 inches of cannel in contact at the top. The immediate roof is shale; clay is under the coal. Graphic sections of the cores are shown on figure 64, section 20 and figure 65, sections 21, 22, 23, 24, 26.

The entry to the Light Coal Company Lindsey No. 8 mine (Fb24) is about 0.4 of a mile southwest of West Eureka No. 3. This was the only sizable commercial mine working the Lower Freeport in the quadrangle when the survey for this report was in progress and it was still producing coal in 1944. Reports indicate that it was originally opened by the Berwind-White Coal Company, but coal was not produced while under that ownership. The present operators began shipping coal in 1910 and operations continued until 1929. From that time until 1934, the mine was idle. Operations were resumed and continued thereafter, and up to and including 1943 about 1,696,000 tons of coal had been produced. The mine is electrified, mechanized, and equipped with a modern steel tipple.

Figure 66. Light Coal Company's Lindsey No. 8 mine.

Approximately 2,260 acres are underlain by the horizon of the Lower Freeport coal in the area north of the improved road along Mahoning Creek and bounded on the east by the coal outcrop along Rose Run to where it forms a neck on Route 536 about 0.6 of a mile

east of Perry Church; on the north by the outcrop along McCracken Run to Grange, and on the west by Perryville and Nicely Runs. Butler sandstone is the cap rock in this area and is generally massive and coarse-grained to finely conglomerate.

The author did not have opportunity to enter this mine; however, information obtained indirectly indicates that it is near exhaustion. The coal is good quality, but clay squeezes are numerous. The normal thickness is 48 inches. The maximum is a little over 60 inches and the bed feathers out at some places or is marked by bony. The roof of the mine commonly is shale, which is in contact with the coal at most places, but up to 30 inches of bony may also overlie the coal. At some places cannel is present at the top; binders and partings are the exception. Clay is nearly everywhere under the coal. Cores of the Lower Freeport obtained by diamond drilling are shown on figure 65, sections 27, 28, 30, 36, 38, 39.

Nicely Run. Excellent exposures of the Lower Freeport were observed on the east side of Nicely Run where the Holcombe Coal Company in 1944 was stripping crop coal. The cut ranges from about 30 to 75 feet wide and extends from the custom bank (Eb38) about 2,200 feet to the northwest. The average thickness of the coal is 48 inches. It is overlain by nearly 25 feet of shale, which is black at the bottom, becoming progressively lighter upward. The shale is overlain by platy Butler sandstone. A thin rider coal is present, but not persistent, and occurs about 20 feet above the Lower Freeport. Lenses and spheroidal aggregates of sulphur are scattered throughout the bed, but bone and shale partings are generally lacking. The coal has a bright luster and occasionally an irideseent sheen. Usually a few inches of cannel occurs on top. The coal has a roughly cubical fracture and breaks out into blocks up to 20 inches in greatest dimension. The face of the coal strikes N.65°W. and the butt N.25°E.

A small country bank, evidently long abandoned, is about 1,400 feet beyond the northwestern end of the stripping (Eb22). When this locality was examined in 1936, crop and pillar coal was being mined in the custom bank referred to above. A section of the coal in that bank is shown on figure 65, section 29. Pillar coal was also being worked in two country banks about 0.3 and 0.6 of a mile, respectively, to the southeast (Eb50, 48). The Lower Freeport is 36 inches thick in the former and 43 inches thick in the latter (fig. 65, secs. 34, 35). The face and butt cleats of the coal in these banks have the same direction, N.60°W. for the face, and N.30°E. for the butt.

Lower Freeport coal had been worked in several drifts in the small ravine to the east and along Mahoning Creek to the southeast (Eb49, 52, 54) (Fb29, 31). These are reportedly the mines of the Ross Run Coal Company, which is a local organization. This company was reported to have two drifts on the same coal on the west side of Nicely Run (Eb39, 46). They were relatively small operations, having produced a total of about 159,800 tons from 1912 to 1919; continuing for a short time in 1923. Custom coal was being mined by an individual in one of these drifts (Eb54) in 1936. A section was obtained

showing 48 inches of bituminous coal and 4 inches of fairly good cannel five inches from the top. Over the coal is 18 inches of shale which in turn is overlain by sandstone. Plastic clay makes the floor (fig. 65, sec. 37).

One of four abandoned drifts along Mahoning Creek south of Lindsey No. 8 mine (Fb27, 28, 32, 33), was the entry to Light No. 5 mine, but its identity could not be determined. The drift below the road was still accessible (Fb27) and a section of the coal bed measured 55 inches. It was roofed by shale and floored by plastic clay (fig. 65, sec. 40). The face of the coal bore N.60°W. and the butt N.35°E. A bloom of the Lower Freeport shows at the outcrop on the road below No. 8 mine (Fb26).

West Eureka No. 7, a slope mine on the east side of Mahoning Creek about 0.7 of a mile northwest of Fordham (Fb34), was operated from 1903 to 1909, producing about 1,175,000 tons. Later it

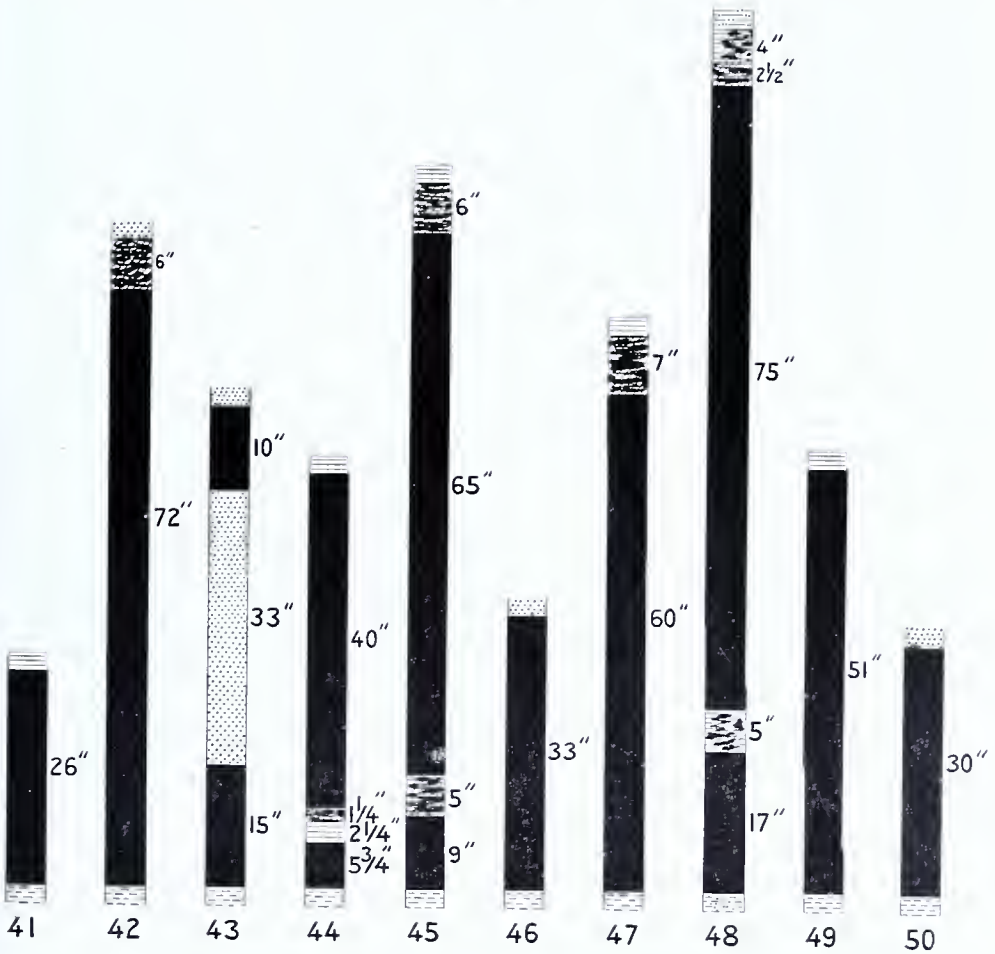


Figure 67. Sections of Lower Freeport coal.

41. Diamond drill hole No. 32. 42. Diamond drill hole No. 38. 43. Diamond drill hole No. 33. 44. Diamond drill hole No. 34. 45. Diamond drill hole No. 37. 46. Diamond drill hole No. 35. 47. Diamond drill hole No. 36. 48. Diamond drill hole No. 39. 49. Diamond drill hole No. 43. 50. Diamond drill hole No. 47.

was worked by a local company. West Eureka No. 4 also is a slope mine. The site of the entry is a little northeast of Fordham. Approximately 1,341,000 tons of Lower Freeport coal were taken from this mine from the time it was opened in 1891 to is abandonment in 1906. The workings of West Eureka Nos. 4 and 7 were reportedly extended southeastward about to the axis of the Punxsutawney syncline where the coal thins naturally and is faulted. Shown graphically on figure 67, section 41, and figure 68, sections 51, 53, are cores of Lower Freeport coal obtained by diamond drilling in this locality.

Fordham. The Vega shaft is at Fordham (Fc18). This mine worked Lower Freeport coal periodically from 1919 to 1931 and produced about 161,000 tons. Its operations extended southward an unknown distance beyond Mahoning Creek. Additional information about the mine is lacking. Another shaft mine called the Light No. 1 and operated by the Light Coal Company of Punxsutawney is about 1,200 feet to the southwest. The workings of this mine were said to extend nearly to the east branch of Dutch Run. The total production from this mine was approximately 494,000 tons and mining operations were pursued from 1920 to 1927. Sections of the Lower Freeport coal in this area were obtained from the records of diamond core drilling. They are shown on figure 68, sections 54, 55, 56, 60, and figure 69, sections 61-64. These sections show the variable character and thickness of the bed. Its maximum thickness is reported to be 80 inches. Normally the roof is shale, but at places the Butler sandstone rolls into and through the coal. Reports of other core drilling in this locality indicate that the coal becomes thin and pinches out near the axis of the Punxsutawney syncline. Analyses of samples from this mine show from 6.1 to 12.8 percent ash and 3.2 to 4.1 percent sulphur. (See analyses, table 2.)

Valier. A relatively large mine, called the Valier, financed by local capital, was situated near Valier Station (Ee13). It began shipping coal in 1903, mining machinery was installed in 1904, and it was in continuous operation until 1918. A peak production of a little over 96,000 tons was reached in 1906. Retreat mining began in 1910 and the total output is 904,000 tons. The normal thickness of the Lower Freeport in these workings is said to be 48 inches and the average range is from 46 to 50 inches. A sizable fault was encountered in the main heading. The Pansy Coal Company, which also was a local organization, worked the Lower Freeport in two mines in this locality. The Pansy No. 1 drift reportedly was situated a little west of Valier (Ee15) and Pansy No. 2 slope is a short distance up Crossman Run (Ec16). These mines were in operation from 1919 to 1929 and had a total production of approximately 671,000 tons. Faults also occur in these workings. Diamond drill tests had been made in this area and coal cores indicated on the obtainable records are shown graphically on figure 68, sections 57, 58, 59 and figure 69, sections 65, 66, 67. As indicated on those sections, the range in thickness of the coal is from 24 to 62 inches. The normal reported thickness is 48 inches. The mines are roofed by either shale or sand-

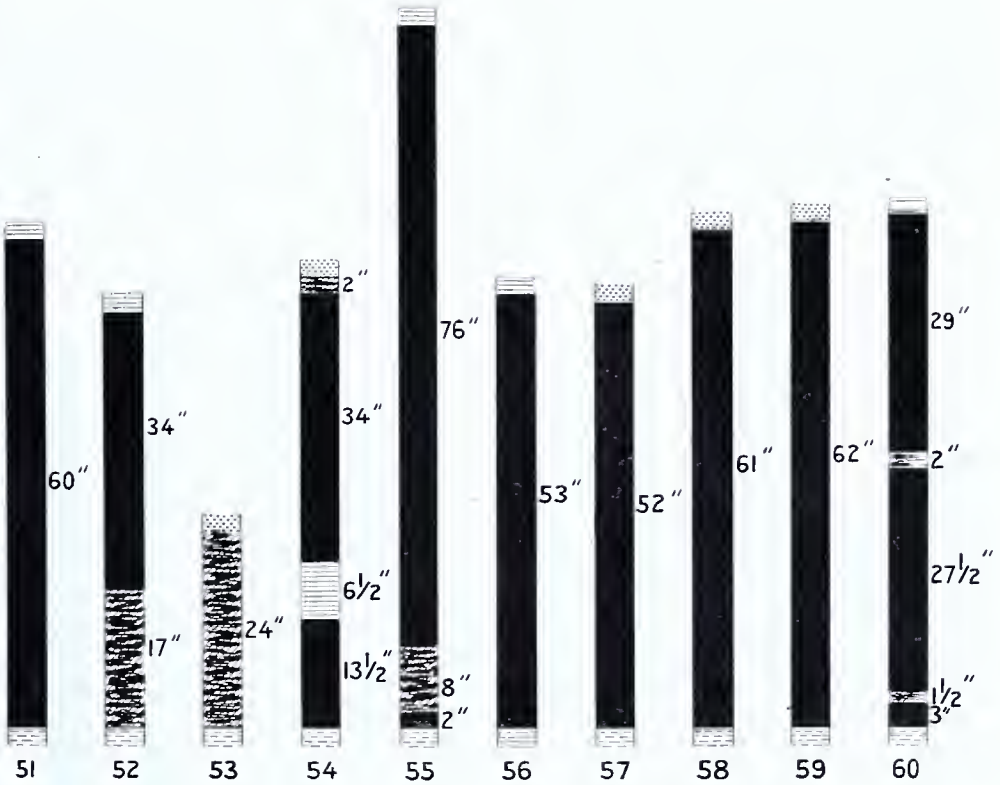


Figure 68. Sections of Lower Freeport coal.

51. Diamond drill hole No. 41. 52. Diamond drill hole No. 40. 53. Diamond drill hole No. 46. 54. Diamond drill hole No. 48. 55. Diamond drill hole No. 50. 56. Diamond drill hole No. 54. 57. Diamond drill hole No. 65. 58. Diamond drill hole No. 64. 59. Diamond drill hole No. 59. 60. Diamond drill hole No. 58.

stone. Up to 12 inches of bony tops the coal locally, and clay usually makes the floor. It is not known exactly how far underground these workings had been extended. Information obtained from reasonably reliable sources reveals that the immediate area had been fairly well tested with the diamond drill. The approximate boundary of workable coal as determined by those tests is shown on figure 63.

Lower Freeport coal was removed from under the area where Mahoning Creek makes a bend around Valier. The Fordham mines entered on the coal on the west side of Mahoning Creek north of Fordham (Fb30, Fc1) and mined out 127,000 tons from 1918 to 1926. The bed had earlier been worked for local use in drift on the west side of Valier (Ec12).

Crop and pillar coal was taken from the Pansy mines through the Sutter Coal Company Hamilton mine, the entries of which are on the east bank of Mahoning Creek near Hamilton Station (Ec7, 8, 9). These were small pick workings having an average daily output of 50 tons, and a total production from 1910 to 1934 of around 269,000 tons. The drifts are inaccessible, but authoritative information indicates that the normal thickness of the bed is 48 inches. An average of 10 inches of bony at the top was taken down in mining and

cleaned by hand. Impurities are generally lacking in the coal and it has a bright luster, breaks out into fair-sized columnar blocks, with 40 percent in lump, 30 percent not in lump, and 30 percent slack. Massive Butler sandstone up to 12 feet thick makes the roof and 2 to 3 feet of plastic clay is under the coal. A few minor openings had been made on the Lower Freeport on the east and south sides

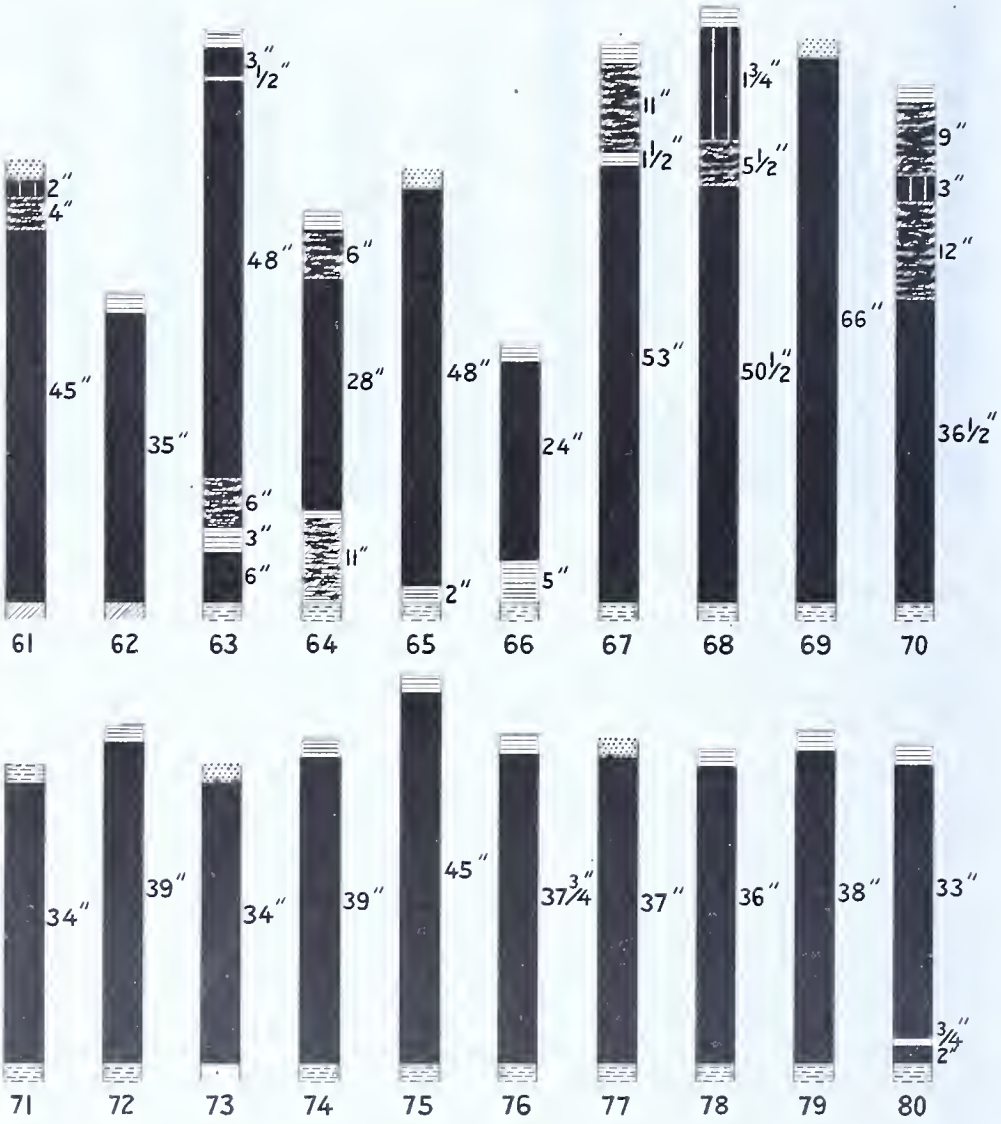


Figure 69. Sections of Lower Freeport coal.

61. Diamond drill hole No. 57. 62. Diamond drill hole No. 55. 63. Diamond drill hole No. 56. 64. Diamond drill hole No. 60. 65. Diamond drill hole No. 63. 66. Diamond drill hole No. 62. 67. Diamond drill hole No. 69. 68. Diamond drill hole No. 66. 69. Ec3, country bank, Crossman farm. 70. Dc4, custom bank, Neal farm. 71. Diamond drill hole No. 11. 72. Diamond drill hole No. 10. 73. Diamond drill hole No. 9. 74. Diamond drill hole No. 8. 75. Diamond drill hole No. 6. 76. Diamond drill hole No. 4. 77. Diamond drill hole No. 7. 78. Db20, country bank, Blose farm. 79. Db17, country bank, Cook farm. 80. Db26, country bank, Blose farm.

of Mahoning Creek, west and southwest of the Hamilton mine (Ec3, 5, Dc8-11). One of these drifts had been reopened (Ec3) and was being worked for domestic fuel. The bed has an observed maximum thickness of 66 inches, and is fairly good quality. It is roofed by sandstone and the floor is clay (fig. 69, sec. 69). The face of the coal bears N.50°W., the butt is indistinct.

Lower Freeport coal was being taken out for custom trade in a drift on the north side of Mahoning Creek, about one mile southwest of Hamilton (Dc4); the section of the bed is as follows: roof, shale; bony, 9 inches; cannel coal, 3 inches; bony, 12 inches; coal, 36½ inches; clay. This section is shown graphically on figure 69, section 70. A caved country bank also on the Lower Freeport is in the small ravine about half a mile to the north (Db32).

Foundry Run. In the area between Foundry and Perryville Runs, from Hamilton north to the Porter-Grange road, and between Moser School and Grange, the horizon of the Lower Freeport occupies about 1,400 acres. The coal in this area had been developed in a small commercial operation and an unknown amount had been removed in country banks. A few diamond drill tests have been made, but these are essentially local and in the southern part of the area where a considerable amount of coal had been taken out. It could not be determined if the larger northern part of the area had been drilled and information about the coal along the outcrop is meager. However, it is possible that are area contains enough coal of workable thickness to represent a potential reserve. The cap rock in the area is massive Butler sandstone.

The outcrop of the Lower Freeport extends to the head of Foundry Run and up its tributaries (Foundry Run referred to here enters Mahoning Creek at Hamilton; another run of the same name enters Mahoning Creek at Milton.) It was traced by the presence of country banks wherein the coal was mined in a small way for domestic fuel. The drift on the Rugh farm near the head of the run (Db9) was closed, but a farmer who claimed to have worked that coal reported that the Lower Freeport occurs in two benches separated by 18 inches of shale. The roof is shale and the floor is clay (fig. 70, sec. 82). Two drifts near-by were also closed (Db3, 10) and information about the coal could not be obtained. The drift on the Stankard farm, 0.8 of a mile to the southwest was open (Db11) and disclosed 31 inches of Lower Freeport, topped by shale and underlain by plastic clay (fig. 70, sec. 84). Lenses of "mother" coal and sulphur are present in the bed. The strike of the face cleat is N.55°W. and the butt is N.35°E. About 0.3 of a mile to the southeast another bank on the Stankard farm was being worked (Db13) where the Lower Freeport has a thickness of 40 inches, is overlain by shale and underlain by clay shale (fig. 70, sec. 83). The Lower Freeport was opened at two places along the east tributary on the Cook estate. The bank farthest up the run was caved (Db19). The one below was active (Db17) and a section was obtained (fig. 69, sec. 79) showing 38 inches of coal, with shale over and clay under it. A drift on the Blose farm, 0.3 of a mile to the south (Db26), was also ac-

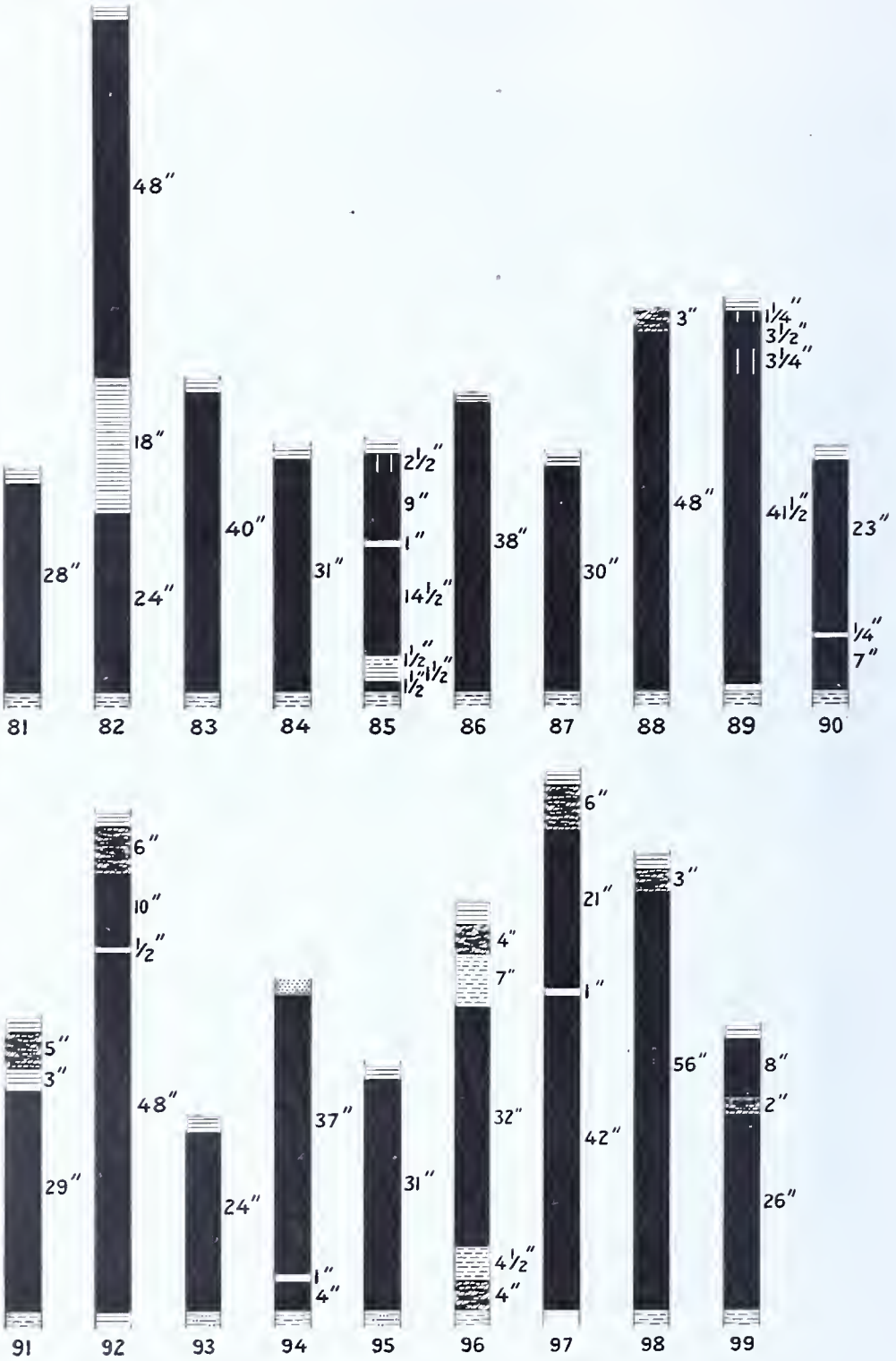


Figure 70. Sections of Lower Freeport coal.

81. Da43, country bank, Kelly farm. 82. Db9, country bank, Rough farm. 83. Db13, country bank, Stankard farm. 84. Db11, country bank, Stankard farm. 85. Cb6, country bank. 86. Cb20, country bank. 87. Cb8, custom bank. 88. Bb32, country bank. 89. Diamond drill hole No. 3. 90. Ca15, country bank, west side of Caylor Run, north of Dora. 91. Ba31, country bank. 92. Aa42, country bank. 93. Cc10, outcrop. 94. Cc7, North Point mine. 95. Diamond drill hole No. 72. 96. Bd3, country bank. 97. Ef13, custom bank. 98. Ef33, custom bank. 99. Ef34, country bank, Wetzell farm.

cessible and the following section was measured: Butler sandstone, thick-bedded, 5 feet; shale, 24 inches; coal, 33 inches with lenses of "mother" coal up to ¾ inch thick; bone, ¾ inch; coal, 2 inches; dark clay shale. This section is also shown graphically on figure 69, section 80. A bearing taken on the face of the coal indicated N.55°W.; the butt cleat was indistinguishable. A bank on the Heitzenreiter farm, about 0.3 of a mile south (Db28), was long abandoned, but it was learned that the Lower Freeport is 34 inches thick normally, but sandstone rolls reduce its thickness to 12 inches. Along the road ascending the hill west from near the mouth of Foundry Run, a poor bloom of the Lower Freeport was noted (Db35).

Perryville Run. The Lower Freeport crops out along Perryville Run to its head-waters south of Grange. The coal had long been worked north of Hamilton for the local market. A relatively recent mine had been operated by P. L. Brown of Punxsutawney, about 0.7 of a mile north of Hamilton (Db23, 24). It was reported that the coal in this mine has a normal thickness ranging from 30 to 44 inches with an occasional few inches of cannel. Diamond drilling had been done in this locality and the cores showed rather clean coal from 34 to 45 inches thick (fig. 69, secs. 71-77). Shale or sandstone commonly tops the coal, but in places it is overlain by plastic clay; clay is everywhere under the coal. A bloom marks the outcrop where it crosses the road to the north (Db21) and a little northwest a country bank was open on the Blose farm (Db20) in which a section of the bed measured 36 inches. The roof is shale and the floor is clay (fig. 69, sec. 78).

Platt[54] obtained a section from an opening on the Lower Freeport also on the Blose farm, but the location could not be found. The section and analysis of the coal are as follows:

	Ft.	*in.*		*Percent*
Coal	1	10	Water at 225°	.880
Cannel slate	0	10	Volatile matter	32.173
Coal	1	5	Fixed carbon	53.496
Slate	thin		Sulphur	3.361
Coal	0	8	Ash	10.090
				100.000

In another bank on the Blose farm, Platt describes the following interesting feature in the Lower Freeport coal. "In one of the entries of the Blose mine a wedge-shaped mass of sandstone comes into the seam below the cannel slate, dividing the bed into two parts, without, however, affecting the quality of the coal in either bench. The sandstone parting is confined to a narrowly circumscribed area. It first appears as a thin knife-edge of rock, which, gradually increasing, becomes 18 inches thick, and is then continuous without change as a compact fine grained sandstone, to the end of the entry. The rock area has a proven length of at least 100 feet, and is about 50 feet across. Horses of clay also disturb the coal considerably. An instance of where the erosive current cutting through the upper

[54] Platt, W. G., Jefferson County: Pennsylvania 2d Geol. Survey Rept. H6, p. 12, 1881.

bench of coal, has been arrested by the hard sandstone mass, is prettily shown at one place in the mine."

Farther up Perryville Run, the Lower Freeport had been opened at four places (Da59, Db4, 6, 7), but nothing could be learned about the coal. An entry on the coal on the Cook farm (Eb16) was open and the coal is 37 inches thick. The mine is roofed by shale and the floor is clay (fig. 65, see. 31). The face of the bed is N.70°W., and the butt N.30°E. The coal had also been opened at near-by places (Eb14, 17, 21) and poor outcrops of the Lower Freeport were seen along the east fork of the road from Hamilton (Eb18, 19). In 1944 the Freebrook Coal Company of Kittanning stripped some Lower Freeport on the east side of Perryville Run. The cut was begun at the point of the hill near a country bank (Eb17) and was extended about 2,000 feet northward, having an average width of 30 feet. A fairly uniform thickness of 36 inches of coal is revealed. At the south end of the stripping, the rider coal appears 6 feet above the Lower Freeport. It has a maximum thickness of 24 inches but feathers out within a short distance. The interval between these coals is occupied by dark to olive shales.

Figure 71. Lower Freeport and rider coal, north of Hamilton.

Beginning in 1922 and through 1930, the Perry Hills Coal Co., having headquarters in Punxsutawney, mined out approximately 648,000 tons of Lower Freeport in three detached areas, comprising about 336 acres north and east of Hamilton (Eb24, 25, 27, 34, 35, 40). Following these operations, some crop and pillar coal was taken out for local use (Eb28), and in 1944 a large amount of crop coal was stripped by the Freebrook Coal Company. As revealed in the stripping, the coal ranges from 42 to 48 inches thick. It contains an occasional binder or parting up to one inch thick, and lenses of "mother" coal are common. A variable thickness of bony or cannel shale usually lies on top, but up to 30 inches of plastic clay is over it at some places. Black shale is generally the immediate roof; it is fissile in part and grades upward through olive shale to platy, argillaceous sandstone. Plastic clay is everywhere under the coal bed. The cleats vary little from N.65°W. for the face and N.25°E. for the butt. Analysis of two channel samples taken near the old entry at the southeast (Eb40) gave 5 percent ash and 1.38 percent sulphur. Complete analysis is shown on table 3.

Frostburg. Lower Freeport had been developed by commercial mining and is being dug for local consumption in the area surrounding Frostburg. Because of structure and erosion, the coal bed lies so near the surface as to afford almost ideal stripping conditions at many places. A notable tonnage was being recovered by such methods in 1944.

Crop coal had been worked in a country bank, 1.5 miles south of Frostburg, on the Mahoney farm (Fb18). The outcrop shows as a bloom (Fb17) where it crosses the road north of the bank; and on the Gould farm north of the road (Fb16), the bed had also been worked for house coal. An abandoned drift (Eb9) is on the McGee farm about 0.6 of a mile west of the Gould bank. A bloom marks the outcrop (Eb7) where it crosses the road north of the McGee bank, and an opening had been made on the Lower Freeport a little to the west on the Couch farm (Eb6). Two drifts on the same coal are on the Shaffer farm to the north (Eb2, Ea41). The one farthest north on that farm was active and the coal was worked for custom trade. The bed measured 53 inches. It is roofed by black shale and underlain by clay (fig. 64, sec. 18). The strike of the face is N.65°W., the butt N.30°E.

Stripping operations were in progress when this locality was revisited in 1944. The cut was started on the Hazlette farm about half a mile southeast of Perry Church, and the outcrop was being followed around the hill on the Couch, McGee, and Shaffer farms. At that time preparations were being made to strip on the McGee farm on the south side of the road. The horizon of the Lower Freeport in this area underlies about 211 acres. The Lower Freeport in the stripping has an observed range in thickness from 39 to 43 inches. It carries up to 14 inches of bony coal and bone at the top, which becomes poor grade cannel within a relatively short distance. Over that is a variable thickness of black to gray shale. The variation in the thickness of the shale is caused by an erosional unconformity with

the overlying Butler sandstone, but the coal was nowhere observed to be affected by erosion. The Butler sandstone is here at least 20 feet thick. It is medium-grained, micaceous, gray, and contains shale chips at some places. It is massive at the bottom, becoming platy and cross-bedded upward. The coal has a bright luster; numerous lenses of sulphur and "mother" coal are present at some places, but at other places are lacking. It has also a subcubical fracture, breaking out into blocks up to 20 inches in greatest dimension. The directions of the face and butt cleats vary little from N.55°W., to N.25°E., respectively.

In the vicinity of Perry Church to the north, Lower Freeport had been mined on a small commercial basis, and custom and country mines were still working crop and pillar coal up to 1943 (Ea29, 30, 32, 42, 44). In 1943 and 1944 some of the remaining crop coal was recovered by strip mining. Beginning near the custom bank a little west of Perry Church (Ea29) in which the section shown on figure 64, section 19, was obtained earlier, the Freebrook Company uncovered the coal a few hundred feet northward, the cut ranging from about 20 to 30 feet wide. It was revealed that the Lower Freeport is exceedingly irregular, being for the greater part rolled into and cut out by the Butler sandstone, and containing numerous clay "horses." Apparently little coal was recovered. Where the bed was not thus affected by erosion, it is overlain by dark shale, has an observed maximum thickness of 62 inches, and gray plastic clay is underneath. Plastic clay also tops the coal locally. The Butler sandstone is here gray to brown, cross-bedded and medium-grained, is massive at the base, becoming flaggy and platy upward. It also contains numerous carbonized plant remains. The face of the coal has an average bearing of N.55°W. and the butt N.25°E. An analysis made for the Freebrook Company, the sample for which having been obtained in the near-by custom bank, shows 8.2 percent ash and 2.28 percent sulphur. For complete analysis see table 3.

Lower Freeport coal was stripped north and east of Perry Church, where, insofar as could be observed in the cut, it had not been affected by erosion, but clay veins in the coal render much of it unrecoverable. A maximum thickness of 59 inches was noted. Clean coal is present, but at some places up to 9 inches of draw slate and bony occur 20 inches from the top. Shale averaging 4 feet thick roofs the coal and it is capped by Butler sandstone. The coal face is N.65°W. and the butt N.30°E.

Approximately 678 acres had been underlain by Lower Freeport coal in an irregular area north of Frostburg and west of Sawmill Run. Economically recoverable coal in that area is practically exhausted. The Frostburg mines (Ea37, 39, 40, Fa30) were finished in the early 1920's. Numerous country banks worked the coal and following our entry into World War II, a considerable tonnage of crop coal was produced by stripping. In the stripping at the east end of Frostburg, north of Route 356, the Lower Freeport is 51 inches thick, has a bright luster, contains some scattered sulphur, and clay has been squeezed into it at some places. The face of the bed strikes

N.55°W. and the butt N.45°E. At one place in the cut the rider coal 8 inches thick appears 19 feet above the Lower Freeport, the interval being filled with dark gray and olive shale. Within a short distance the rider splits into two thin benches, each feathering out farther on. The coal at one time was worked for house fuel at two places close to Frostburg (Fa31, 32). Two abandoned country banks occur about 1.2 miles northeast of Frostburg (Fa23, 28), and on the north side of the hill from there the Lorenzo Coal Co. stripped some crop coal.

A section was obtained in the early part of the field work in a country bank (Ea38) working pillar coal. It was situated about one mile west of Frostburg and revealed 59 inches of coal topped by 6 inches of bony, overlain by black shale and underlain by plastic clay (fig. 64, sec. 8). Stripping operations have been pursued along the outcrop almost continuously in the area west of Frostburg and the sites of preexisting drifts shown on the mineral resources map have been obliterated. A little to the east of the above drift, the Lower Freeport was exposed in the stripping, where the coal section is as follows: roof, black shale, 10 feet plus; coal, 14 inches; impure cannel, 9 inches; shale parting, ¼ to ½ inch; coal, 48 inches, bright luster with iridescent sheen in part; plastic clay. Clay squeezes are present and the coal face is N.60°W. In the stripping just east of where the outcrop of the Lower Freeport is indicated on the road north from Perry Church (Ea27), the following section was obtained: roof, dark shale; bony, 4 inches; coal, 7 inches; cannel, 3 inches; binder, ¼ inch; coal, 53 inches; plastic clay. The bed is moderately hard, has a bright luster, and the main bench is apparently free from impurities. The face cleat has a local variation from N.50°W. to N.65°W, the butt is N.15°E.

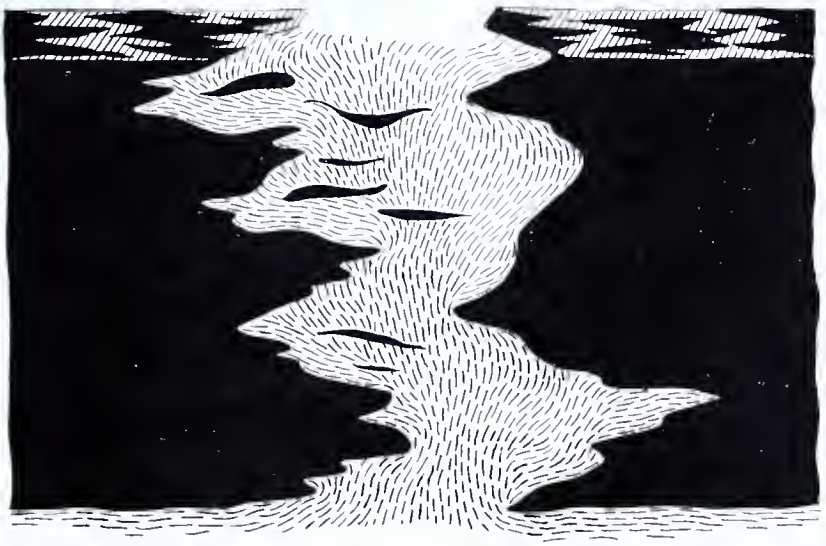


Figure 72. Sketch showing clay squeeze in Lower Freeport coal, northwest of Frostburg.

Figure 73. Lower Freeport coal exposed in stripping north of Frostburg.

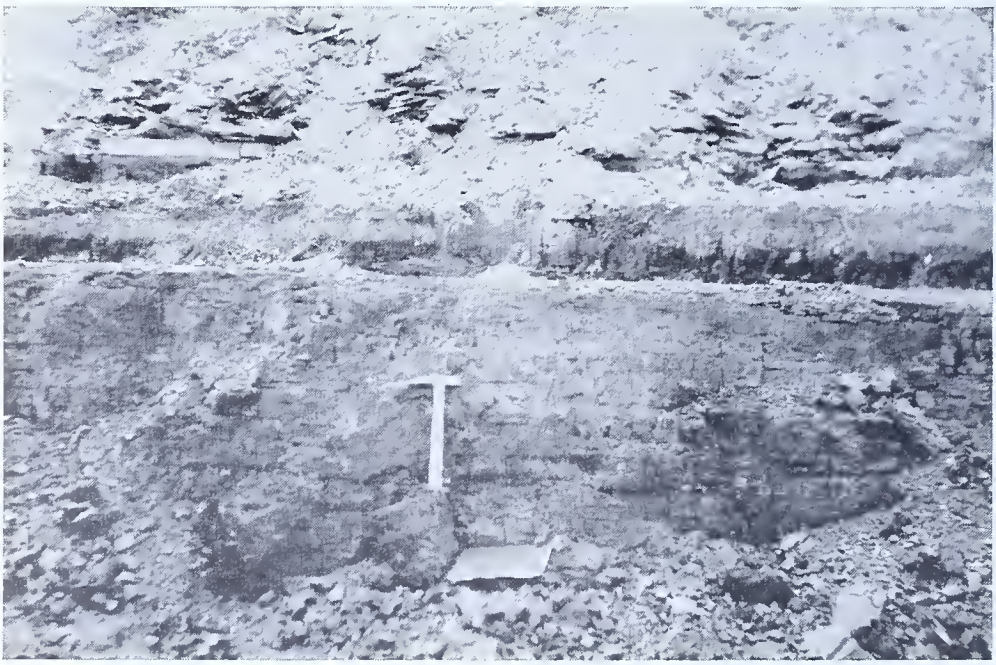


Figure 74. Section of Lower Freeport coal in stripping north of Frostburg.

The Lower Freeport had been mined for custom trade on the Lewis farm about 0.4 of a mile northwest of the above location (Ea26). A section of the coal in that drift is shown on figure 64, section 7. The coal was stripped early in 1944 on the west side of the hill. The opening cut was made just north of the custom bank, and the stripping

was extended nearly to the road west from the road intersection (elevation 1584 feet) 1.4 miles north of Perry Church. In this stripping the coal ranges from 50 to 60 inches thick. It has a bright luster and breaks out into blocks up to 12 inches in largest dimension. A few nonpersistent shale partings up to one inch thick occur near the bottom. Lenses of mother coal are also present. The face of the coal ranges from N.55°-65°W.; the butt is N.15°E. Clay squeezes are occasionally present and an excellent example of one was exposed at one place in the cut (see fig. 72). An opening had been made on the coal many years ago on the northeast side of this hill (Ea22).

A small patch of Lower Freeport occurs in the hilltop west of the Lewis bank (Ea24). Most of the coal has been removed by recent stripping. The maximum cover is about 12 feet thick and is composed of shale and sandstone. The sandstone rolls into the coal at some places. The average normal thickness of the coal is 31 inches. Lower Freeport also occurs in three small isolated patches north and northeast of the Lewis bank. Most of it had been worked out in country banks (Ea14, 15, 16) and since World War II, the remaining recoverable coal was stripped. Spoil concealed the coal in the stripping to the north, but in the Straitiff stripping to the northeast, a maximum thickness of 65 inches was observed and a thickness of 72 inches was reported. A few thin partings and "mother" coal are present locally. The bed is topped by 2 to 10 inches of bony and appears to be everywhere overlain by dark shale (fig. 64, sec. 6).

Stripping was also done on the Lower Freeport south of the Straitiff operation, where a few drifts had been working pillar and crop coal in the abandoned Frostburg mines (Ea20, 19). As disclosed in this cut, the coal has a normal range from 60 to 70 inches thick. Its luster is bright and it is medium-hard. A nonpersistent shale parting up to one inch thick is present near the top and also near the top occurs locally a few inches of cannel. Sulphur streaks are common and the coal is usually topped by bony that averages about 4 inches thick, but draw slate occupies its place locally. Dark, gray, and buff shale having a thickness up to a noted 15 feet overlies the coal, over which is Butler sandstone, commonly fine-grained, platy to flaggy, and tan to whitish. Much of the coal is rendered unrecoverable by numerous clay "horses." The face of the bed varies from N.60°-70°W., and the butt from N.15°-30°E. An analysis of the Lower Freeport in this stripping indicates 3.8 percent ash and 0.57 sulphur. For complete analysis see table 3.

The outcrop of the Lower Freeport south of Frostburg is marked by abandoned country banks (Fa34, 33, Eb3). Some coal was stripped immediately east and south of the village. Water was ponded in the pit at the east. Coal in the one to the south measured 39 inches, having 6 inches of bony on top and at least 19 feet of shale. An observation on the coal face indicated N.75°W. and the butt N.30°E. Pillar coal was worked for custom trade in abandoned mine workings east of Frostburg (Fa35-38). Two of these drifts were accessible. In the one (Fa35), the Lower Freeport is 40 inches thick. It is topped by black shale and underlain by clay (fig. 64, sec. 11). The face cleat

is N.65°W. and the butt N.25°E. In the other drift (Fa38), the coal is 47 inches thick, including a ½-inch parting 15 inches from the base. Black shale lies on top and clay below (fig. 64, sec. 15). The face and butt cleats are N.75°W. and N.35°E., respectively. The outcrop of the coal is exposed in a gutter on Route 36 (Fa39) where the section of the bed is similar to that in the near-by drift (fig. 64, sec. 14). As exposed in the road cut, the section above the coal shows, in ascending order, 25 feet of dark to light shale, sandy shale, shaly sandstone, and clay, above which is the Lower Freeport rider coal (Fa40). Although considerably weathered, this coal is at least 39 inches thick and overlain by dark shale. A caved mine entry is below and on the east side of Route 36 a short distance southward (Fa41). The Lower Freeport outcrop forms a "fenster" on the west side of Route 36 at the head of a run a little farther to the south. Caved mine workings are indicated on the surface in this locality. Pillar and crop coal had been worked in a country bank (Fa44) and the bed is partly exposed near-by (Fa43).

North of Sawmill Run to Little Elk Run an area of approximately 470 acres contained Lower Freeport. The coal was worked through the Walston mines, the entries to which are in the Punxsutawney quadrangle. Pillars and stumps were being removed in small commercial operations and some country banks in the Smicksburg quadrangle. In 1943 and 1944 a large quantity of coal was stripped. The bed is persistent in this area, has an average thickness of about 60 inches and a known range from 36 inches at the southwest to a little over 100 inches near the boundary of the quadrangle. It has dominantly a bright luster with dull bands from a knife edge to 3 inches thick. Visible impurities are lacking at some places, but one or more binders usually are present. A fairly persistent binder up to 2 inches thick occurs near the bottom and lenses of mother coal also are in the bed. A layer of bony on top characterizes the coal in this area; shale commonly is over, and clay is under the bed. Clay veins are numerous. They are reported to be particularly numerous near the outcrop and it was observed that they penetrate the coal near the apex of drag folds. Fine examples of the latter are displayed in the strippings.

The Lower Freeport is 63 inches thick in a country bank situated above Sawmill Run near the eastern boundary of the quadrangle (Fa26). A 1½-inch binder is 22 inches from the top; 12 inches of bony is in contact at the top, over which is 9 inches of shale, then sandstone. Clay is under the coal (fig. 64, sec. 13). A country bank on the opposite side of the hollow was caved (Fa27). The coal was stripped late in 1943 along the run to the east, where the bed has a maximum observed thickness of 96 inches. It is topped by 12 to 18 inches of bony, over which is about 20 feet of shale, then sandstone. A few streaks of sulphur, and thin, nonpersistent binders are in the coal. Clay veins also are present. The face and butt cleats are, respectively, N.45°W. and N.35°E. Two small drifts had been opened on the coal farther up the run (Fa25). A section of the bed in one of these drifts is shown graphically on figure 64, section 12.

The Freebrook Coal Co. stripped from near the drift on the west side of the run nearly to the road at the head of the run farther west, and recovered about 100,000 tons. An average of 60 inches appears to be the normal thickness of the bed, but locally it thickens to 108 inches. A layer of bony averaging about 10 inches thick is on top. The cover is shale from 10 to 20 feet thick; then Butler sandstone up to 30 feet thick. The maximum overburden removed is about 50 feet. Visual impurities in the coal are generally lacking, but clay veins are numerous, especially toward the outcrop. At one place in the cut, the base of the Upper Freeport limestone appears 31 feet above the top of the Lower Freeport. An analysis of a sample of the coal in this stripping showed 4.77 percent ash and 0.78 percent sulphur. (See complete analysis, table 3.) The average strike of the coal face is N.55°W. and the butt is N.45°E.

A country bank on the Lower Freeport on the McQuown farm on the north side of the hill (Fa18) disclosed 74 inches of clean Lower Freeport. In contact with the coal at the top is 8 inches of bony. The roof is sandstone and the floor is clay (fig. 64, sec. 5). The face of the coal bears N.55°W. and the butt N.30°E. Frostburg No. 13 mine is near the head of Sawmill Run (Fa24). It was a pick mine having an average daily output of 50 tons. Coal was hauled by wagon to the tipple at Frostburg. The bed has a rather uniform thickness of 60 inches. Numerous clay veins interrupt the seam and frequently split it from top to bottom. A persistent 1-inch binder occurs 8 inches from the floor. About 10 inches of bony lies on the top of the coal; broken shale that falls readily is the roof, and 2 to 3 feet of soft clay makes the floor. The coal is dull and croppy. It has a columnar block fracture and mines out in 30 percent lump, 30 percent not in lump, and 40 percent slack. Late in 1943, the entry to this mine was obscured by stripping operations.

Small country banks worked the Lower Freeport north of the Frostburg mine (Fa13-16, 19, 20). All but one of these drifts were closed. In the one accessible (Fa14), the coal is 65½ inches thick, including a 1-inch shale binder 12½ inches from the bottom; shale is the roof and plastic clay is the floor (fig. 64, sec. 3). The face cleat bears N.65°W. A small commercial operation on the Lower Freeport, called the Smith mine (Fa8), is just southeast of Oliveburg. It is a pick mine producing about 50 tons per day and having a total production from 1923 to 1926 of approximately 21,000 tons. The coal is under relatively little shale cover, and is consequently dull and croppy. It has a uniform thickness of 60 inches; 12 inches of bony lies on top, and a rather persistent 2-inch binder occurs 8 inches from the floor. About 4 inches of clay makes the floor. Clay squeezes are present but relatively less numerous (fig. 64, sec. 2). Some Lower Freeport had been taken out in small workings north of the Smith mine (Fa2, 3, 4). The coal is under small enough cover in this locality to be attractive for strip mining. Three small areas in the northeastern corner of the quadrangle contain Lower Freeport. The coal has been mined through country banks (Fa5, 6, 7). Two of these banks were inactive and closed. A section of the bed obtained in the bank at

the northern border of the quadrangle (Fa5) shows that the coal there occurs in four benches separated by slate and bony and totaling 67 inches of coal (fig. 64, sec. 1). A patch of Lower Freeport south of Oliveburg was being mined in two country banks. The bank on the Jordon farm was closed (Fa12). In the opening on the Caylor farm (Fa11) the coal is 36 inches thick and 9 inches of bony lies on top. The mine is roofed by dark shale and floored by plastic clay (fig. 64, sec. 4). Stripping equipment was being moved into this locality when it was last visited, in 1944.

Two small patches of Lower Freeport are in the hilltops west of Oliveburg where the bed had been worked for house coal at two places on the Sivering farm (Ea7, 9). The drifts were closed when the area was first examined. Coal was stripped on the east side of the road early in 1944. The bed averaged about 36 inches thick, is rather clean, and has a maximum cover of about 12 feet of olive and gray shale. The operators took this coal to be the Lower Freeport. It was later discovered that it is the rider coal and that Lower Freeport is about 25 feet below. Stripping was then begun on the lower coal, disclosing that it is very irregular, ranging from 18 to 72 inches thick, and clay veins are numerous. Olive shale and argillaceous sandstone are the cover. The face cleat bears N.55°W.; the butt cleat is indistinct. A coal considered to be Lower Freeport and reported as 24 inches thick, underlies a very small area on the Aber farm (Ea4) about one mile northwest of the Sivering stripping.

The Lower Freeport had been opened on the Postlewaite farm (Da42) and the Kelly farm (Da43) north of Grange. At the latter place it is 28 inches thick and is overlain by shale and underlain by clay (fig. 70, sec. 81). Stripping on the Postlewaite farm in 1944

Figure 75. Stripping on Lower Freeport coal, west of Oliveburg.

showed that the coal on the east side of the road near the old drift is 32 inches thick, has a bright luster, is fairly hard, contains streaks of sulphur and lenses of mother coal, and has up to 13 inches of draw slate on top. Over that is shale, sandy shale, and shaly to flaggy sandstone. A composite of three channel samples shows an analysis of 11.0 percent ash and 3.9 percent sulphur (see complete analysis, table 3). The face of the coal bears N.55° W., the butt N.35° E. In the cut on the west side of the road, the coal ranges from 28 to 30 inches thick and its character is similar to the above. The overlying sandstone has become heavy-bedded and is at least 20 feet thick. A bloom marks the Lower Freeport outcrop where it crosses the road (Da40). A small amount of the same coal occurs in the knoll to the north (Da39), where it is 29 inches thick and has up to 20 feet of shale cover. Most of the coal here was removed by strip mining. The Lower Freeport has been eroded in the area north of the tributary of Big Run that heads at Grange, but it is preserved on the south side of that stream, as evidenced by two abandoned country banks (Da44, 38).

Pine Run District

The Lower Freeport coal in the Pine Run district is not well known. It was opened only at a few scattered places, but the outcrop was noted as a bloom at numerous places. Some exploration with the core drill has been done and information obtained from various authoritative sources is in accord in the conclusion that the Lower Freeport is erratic, although locally it is thick enough to mine and has an excellent quality. The horizon of the Lower Freeport underlies large areas in this district and inasmuch as little is known about the coal, it should not be condemned as a possible future reserve. In this connection, it is well to use caution in appraising a coal bed. When Platt [55] examined this area, he obtained a few unfavorable observations on the Lower Kittanning coal, and concluded, therefore, that the coal would not have much importance, whereas it developed later that the Lower Kittanning is a valuable coal in this area.

The presence of the Lower Freeport is indicated by abandoned country banks 0.7 of a mile northwest of Grange on the Smith farm (Da46), in a ravine 0.8 of a mile west of Grange (Da54) and on the Shaffer farm 1.4 miles west of Grange (Ca40). Information about the coal at those places could not be had. The outcrop makes a fair bloom on the road a little southwest of St. Johns Church to the north (Da33), also on the abandoned township road at the northern border of the quadrangle (Ca3). A diamond drill hole (1) on the Smathers farm, 1¼ miles northeast of Ringgold (fig. 33, sec. 155), recovered a core showing 10 inches of Lower Freeport coal. The outcrop is marked by a thin coal smut on the road at the head of Caylor Run (Ca9) and on the road along Caylor Run toward Dora (Ca23).

At the head of Middle Branch, which enters Pine Run east of Dora, the Lower Freeport is worked for house coal (Cb6). It is there 27 inches thick, including 2½ inches of cannel at the top and a 1-inch shale parting in the middle (fig. 70, sec. 85). The face of the coal

[55] Platt, W. G., op. cit., p. 42.

is N.50°W. Caved country banks on the coal are situated to the north (Cb5) and to the west (Cb7). On the road toward Dora, the Lower Freeport is being mined for custom trade (Cb8). It is 30 inches thick and appears to be of good quality. The mine is roofed by shale and is underlain by 45 inches of plastic clay. The direction of the face cleat is N.50°W. and the butt is N.35°E. (fig. 70, sec. 87). A diamond drill hole (3) on the McClure farm south of Dora disclosed the Lower Freeport to be 49 inches thick (fig. 70, sec. 89). The coal makes a poor outcrop on the road south from Dora (Bb3).

North of Dora on the west side of Caylor Run, the Lower Freeport is being mined for local use (Ca15). The coal is 30 inches thick and has a 2¼-inch shale parting near the bottom. The roof at the drift is shale and the floor is clay. A bearing on the coal face indicated N.50°W., the butt N.45°E. (fig. 70, sec. 90). The Upper Freeport limestone is 30 feet above. A small commercial operation on the Lower Freeport, called the Young mine, was started near the Eagle Valley mines northwest of Dora (Ba35). The coal was reported to be up to 56 inches thick but very irregular, and the project was abandoned. An opening made 0.3 of a mile north of Timblin (Ba31) disclosed 29 inches of dirty coal, topped by shale and bony (fig. 70, sec. 91). The Lower Freeport here is 30 feet below the Upper Freeport, which was being mined. The outcrop makes a poor showing on the road south from Timblin below the Mill mine (Ba42).

A coal bed 72 inches thick was opened in a country bank (Ba14) near the head of Eagle Run, north of Timblin. It lies about 80 feet below the Upper Freeport horizon. The author has mapped this bed as Upper Kittanning, but other observers disagree with that correlation and call it the Lower Freeport. Platt [56] also described the coal as Lower Freeport and gives an interval of 70 feet to the Upper Freeport. The greatest Upper Freeport-Lower Freeport interval that the author observed in this area is 60 feet, and that occurs north of Charleston along Mudlick Run in the Rural Valley quadrangle. Diamond core drilling west of Ringgold shows that the interval between those beds ranges from 30 to 40 feet. Also, a bloom of the Lower Freeport is 30 feet below the Upper Freeport at the head of Eagle Run. This bed, therefore, is described in some detail under Upper Kittanning coal farther on in this report.

A weathered outcrop of the Lower Freeport occurs on the road that crosses the hill between Eagle and Painter Runs (Ba13). An opening (Ba10) had been made on the coal at one time a little to the north of the above outcrop, but no one could be found who had information about the coal. The Lower Freeport was also seen in weathered condition north of Mt. Tabor near the border of the quadrangle (Aa3), and on the road near the top of the hill south of New Salem (Aa30).

A country bank was open on the Lower Freeport in the hilltop on the north side of Pine Run (Aa42). The section obtained in this bank showed 58 inches of coal, including a ½-inch parting 10 inches from the top; 6 inches of bony is in contact at the top and it is over-

[56] Platt, W. C., op. cit., p. 44.

lain by dark shale (fig. 70, sec. 92). The face cleat bears N.55°W. and the butt N.35°E. When the locality was revisited in 1944, about 25,000 tons had been stripped from this hilltop. The bed as seen in the cut has a maximum thickness of 60 inches, and is generally clean and good quality. An analysis of the coal gave 3.06 percent ash and 0.81 percent sulphur (see table 3 for complete analysis). The stripping shows that the coal occurs in a pocket and has a maximum overburden of 20 feet. Two checked barometer readings indicate that the coal is at an elevation of 1445 feet. The hilltop is contoured at 1520 feet. It is apparent, therefore, that the topography is in error.

The Lower Freeport coal shows as a bloom along the township road on the upland just south of Pine Run toward the western boundary of the quadrangle (Ab1, 4), along the "black top" road ascending the hill southward from Pine Run toward McGregor (Ab12); in the lane just east of the "black top" road about half a mile farther south (Ab20); on the road going west from McGregor at the western boundary of the quadrangle (Ab37); and a little south of McGregor on the road toward Milton (Ab31). The Hallett Coal Co. was making churn drill tests on the Lower Freeport in July 1944 in the area immediately west of McGregor. Eight tests completed at that time showed a maximum thickness of 48 inches of coal. The bed appears to be irregular and some of the holes encountered only sandstone.

A caved drift on the Lower Freeport (Bb9) is on the brow of the hill on the south side of Nye Branch about 0.9 of a mile northeast of McGregor. The Lower Freeport had been opened (Bb7) and reported to be 36 inches thick on the north side of Nye Branch about 0.9 of a mile northeast of the above drift. A test pit about 0.3 of a mile south of the latter place showed 18 inches of Lower Freeport (Bb14) and the outcrop makes a bloom (Bb17) on the road ascending the hill northward toward Dora; also on the road just north of Porter (Bb28).

Lower Freeport coal was being worked in a country bank (Bb25) on the Kunselman farm about 1.2 miles east of McGregor. The bed is 45 inches thick and has soft shale over it. The analysis of the coal in this drift shows 8.9 percent ash and 1.8 percent sulphur. (For complete analysis see table 3.) A caved bank is at the road intersection a little to the west (Bb22) and a poor outcrop shows on the road a short distance along the road southward (Bb23). A drift (Bb24) wherein the Lower Freeport has a thickness of 48 inches was opened on the Powell farm just east of the outcrop on the road. The roof is soft shale. A composite analysis of two channel samples showed 6.4 percent ash and 1.09 percent sulphur. (See table 3.) A country bank (Bb32) also on the Lower Freeport is at the head of Foundry Run about 0.3 of a mile south of the Powell bank. The bed is 48 inches thick and is free from visible impurities; three inches of bony lies on top and the roof is clay shale (fig. 70, sec. 88). The face of the coal bears N.60°W., the butt N.35°E. A thickness of from 36 to 60 inches of Lower Freeport was said to be present in an abandoned drift (Bb36) on the Brumbraugh farm 0.3 of a mile south from

the latter place, and the coal, reported as 36 inches, also had been opened (Ab33) about half a mile west of the Brumbraugh drift.

North Point-Smicksburg District

The North Point-Smicksburg district includes the area drained by Mahoning Creek from a little east of North Point to near the western boundary of the quadrangle and the area drained by Little Mahoning Creek surrounding Smicksburg. Information about the Lower Freeport in this district is scanty. One commercial mine had worked the coal, and country banks had been opened on it at various places, but most of these are long abandoned and closed. Indirect information was usually lacking. From what meager data were obtained, however, the bed appears to be fairly persistent, and most of the sections obtained show a general thickness of a little over 30 inches, and fairly good quality. The horizon of the Lower Freeport is above drainage throughout nearly all of the district, and underlies very large areas. It is, therefore, possible that future exploration may reveal deposits of some economic value.

The Lower Freeport had been worked for house coal in a country bank on the Weaver farm about half a mile southeast of North Point (Dc19). The drift was closed when the locality was first examined by the author. A mining company later opened a test pit on the coal and found it to be from 36 to 40 inches thick, containing sulphur streaks and having a rolly shale and sandstone roof. Analysis of the coal showed 7.6 percent ash and 3.67 percent sulphur. (For complete analysis see table 3.) The coal crops out in a weathered condition on the bluff above the improved road a little to the north of the Weaver bank. An abandoned country bank on the Lower Freeport is on the north side of Mahoning Creek about half a mile northeast of North Point (Db17), and blooms of the coal were noted north and northwest of North Point (Ce5, 6, 8).

The North Point mine, which was operated by the North Point Coal Mining Co. of Indiana, is on the point of a hill a little west of North Point (Ce7). The mine was active from 1922 to 1927 and produced approximately 38,000 tons of Lower Freeport coal. It was a pick mine and had a workable area of 150 acres. The coal has a rather uniform thickness of 42 inches. A persistent 1-inch binder occurs four inches from the floor, but the coal is otherwise rather clean (fig. 70, sec. 94). Butler sandstone everywhere forms the roof of the mine, and it parts free from the coal. It is hard and massive and has a reported maximum thickness of 30 feet. The sandstone faults the coal on the west side of the mine. Plastic clay about 3 feet thick makes the floor. The coal has a predominantly bright luster, is medium hard, and has a columnar block fracture; it mines out in 20 percent lump, 20 percent nut in lump and 60 percent slack. The coal was chuted down a 1000-foot plane into cars on a siding.

Loop. Lower Freeport coal had been worked in a small way on the north side of Mahoning Creek about half a mile east of Loop (Cc14), and a short distance north of Loop (Bc11). The bed is exposed on the steep hillside a short distance up Hamilton Run (Cc10) where a

section showed 24 inches of coal overlain by shale and underlain by sandy shale (fig. 70, sec. 93). A test pit was made on the Lower Freeport about 1.1 miles up Hamilton Run on the Crowe farm, where the bed is 36 inches thick, contains an irregular clay parting, and has a poor shale roof. A composite analysis of two channel samples gave 8.5 percent ash and .67 percent sulphur. A caved bank, also on the Lower Freeport is about half a mile farther up the stream (Cb17); and a weathered outcrop of the coal was observed at the road intersection above (Cb13). About 0.6 of a mile up the east fork of Hamilton Run, a small drift opened on the Lower Freeport (Cb20) revealed 38 inches of rather clean coal, roofed by shale and underlain by plastic clay (fig. 70, sec. 86).

A bloom of the Lower Freeport was noted along the road that traverses the neck of land formed by the bend of Mahoning Creek south of Loop (Cc22). The coal had been worked for domestic use in the ravine on the east side of Mahoning Creek south of Loop (Cc27) and it was learned that it is 36 inches thick. The same bed also had been worked on the Elkin place in the bluff a little farther to the southwest (Bc38) where it was reported as being 27 inches thick.

The Lower Freeport coal had not been observed in the district northwest and west of Loop. Toward Milton remnants of the horizon occupy the higher hilltops, and west of Milton rocks in the upper part of the Allegheny group have been eroded. The coal appears to be poorly developed or missing in the vicinity of Dayton. A poor outcrop was seen on the road leading eastward from Dayton (Ac52), and an opening had been made on it in a ravine to the south of that road (Ac53), but apparently little if any coal had been removed.

Smicksburg. The first known appearance of Lower Freeport coal southeastward in the valley of Little Mahoning Creek is where a drift entered it on the west side of the creek, about half a mile west of Smicksburg (Bd2). The thickness of the bed is reported to be 36 inches. The Lower Freeport was being worked in a drift just above water level on the north side of the creek opposite Smicksburg (Bd3). The coal in this mine is 32 inches thick, and contains numerous sulphur streaks. It is topped by 7 inches of hard plastic clay, 4 inches of bony, and roofed by shale. Under the coal is 4½ inches of soft plastic clay, 4 inches of bony; then hard plastic clay (fig. 70, sec. 96). The Upper Freeport coal, marked by a few inches of carbonaceous shale, is about 60 feet above. Lower Freeport coal also was mined in a small way at the east end of Smicksburg on the west side of the creek (Bd5) where it is 30 inches thick. A drift was opened on this coal many years ago on the west side of the creek about 1.5 miles northwest of McCormick (Cd22). The coal is 36 inches thick, but poor in quality where it had been entered in a small country bank on the north side of the creek 0.7 of a mile west of McCormick (Cd26). A weathered outcrop of a thin coal believed to be the Lower Freeport occurs on the road a little east of McCormick (Dd14), and a core showing 31 inches of Lower Freeport was taken in a diamond drill hole (72) 1.3 miles southwest of Trade City (fig. 70, sec. 95).

Marion Center District

Influenced by the Richmond anticline, the crop line of the Lower Freeport appears above drainage at Marion Center and southwest along Pine Run. It rises above Pickering Run about one mile from its mouth, and appears above Little Mahoning Creek about 1.5 miles from the eastern border of the quadrangle. Southeastward, on and near the axis of the anticline, the coal horizon has been raised into the upland. Excepting a relatively small area south of Marion Center where the Lower Freeport had been mined on a commercial basis, little information was obtainable about the coal elsewhere in the district.

The Marion No. 1 mine, owned by the Marion Center Coal Mining Co., was operated from 1917 to 1924 and produced approximately 370,000 tons. The entry to the mine is situated about 0.7 mile south of Marion Center (Ef16). The workings were driven southeastward into the Indiana quadrangle. It was a pick and machine mine having an average daily output of 300 tons. The average thickness of the bed is 42 inches. The coal commonly is clean, but a parting up to one inch thick is present at some places. Rock rolls and clay veins interrupt the bed at various places. Normally, the mine is roofed by up to 30 feet of dark shale, and coarse-grained sandstone up to 45 feet thick is the cap rock. The floor is impure clay from 3 to 12 feet thick. The coal is dominantly bright, medium hard, has a rough fracture, and breaks out in mining into 40 percent lump.

Lower Freeport was being worked for local use in a country bank (Ef33) about 0.7 of a mile south of the Marion line. The coal in this drift is rather clean and is 56 inches thick. It is topped by 3 inches of bony and has a shale roof. The coal is underlain by clay of unknown quality (fig. 70, sec. 98). A country bank 0.4 of a mile to the east (Ef34) has 34 inches of Lower Freeport, with a 2-inch parting 8 inches from the top. The roof is shale and the floor is clay (fig. 70, sec. 99). The same coal shows as a bloom where the outcrop crosses the road a little to the north (Ef35).

Weathered outcrops of the Lower Freeport were found along Pine Run southwest from Marion Center (Ef6, 25, 26, 28, 29) and it had been mined in two country banks (Ef31, 32), but nothing of the nature of the coal could be learned. Two caved drifts on the Lower Freeport are situated immediately south of Marion Center (Ef7, 8). Platt [57] gives a description and analysis of the coal in an opening at the west end of the town as follows:

"The coal is very inferior quality. It carries large quantities of ash (slate) and also much sulphide of iron (pyrites). The accompanying analysis, made by Mr. McCreath, from a carefully selected specimen taken from the J. Brady Mine, requires no additional comment. It is as follows:

"Water	.920		
Volatile matter	31.320		
Fixed carbon	57.266	Coke percent	67.760
Sulphur	2.669	Color of ash—dirty gray, pink tinge	
Ash	7.825		
	100.00		

[57] Platt, W. G., Report on progress in Indiana County: Pennsylvania Second Geol. Survey, vol. H4, 1887, p. 258.

The coal is bright, shining, iridescent, with numerous thin partings of mineral charcoal and iron pyrites."

The bed is split in half by a thin, but persistent band of slate. It rests regularly upon an even floor of clay, and is roofed by a thick stratum of rough black slate. The following is an average section of the bed worked at Marion:

Slate	
Coal	1'8" - 2'0"
Slate	thin
Coal	1'1" - 1'6"
Clay	

The outcrop of the Lower Freeport is marked by caved openings along the paved highway leading southeast from Marion Center (Ef9, 14, 18, 19, 21). Custom coal was being mined in a drift about 0.4 of a mile southeast of the town (Ef13). The coal there occurs in two benches, 21 and 42 inches thick, separated by a 1-inch parting. On top of the coal is 6 inches of bony, which comes down in mining, and the roof is dark shale at least 15 feet thick (fig. 70, sec. 97). Numerous lenses of mineral charcoal or mother coal are in the bed. The face cleat bears N.55°W.

Two caved country banks on the Lower Freeport are located a little southeast of Marion Center (Ff12, Ef12). The outcrop makes a poor showing on the "black top" road leading west from the town (Ff11); and a bloom of the coal appears about 0.8 of a mile on the first road leading southward from the "black top" road (Ff28). Farther east on the "black top" road, the presence of the coal is indicated by a bloom in the lane on the Beatty farm north of Lohman School (Ff17). In a lane going south near Lohman School, the outcrop of the Lower Freeport at one place is marked by plastic clay (Ff23) and at another place by a coal smut (Ff30). Evidence of the presence of the Lower Freeport was seen in material dug from a small pit in the hillside on the Reithmiller farm, 1.1 miles southeast of Lohman School (Ff33), and the coal makes a good bloom (Ff32) at the eastern boundary of the quadrangle on the road leading southeast from Lohman School. On the improved road eastward from Lohman School, the Lower Freeport had been mined in a country bank a little north of the improved road a short distance in the Punxsutawney quadrangle and it there is said to range from 30 to 36 inches thick.

A caved country bank on the Lower Freeport is on the Clyde farm, southeast of the improved road trending northeast from Marion Center (Ff9). The outcrop of the coal was located by blooms along the same road north of Pickering Run (Fe35, 38). Information about the bed could not be obtained where it had been opened at the head of a run south of the road (Fe41) and the presence of the coal is indicated also by poor exposures in the locality of Stuehel School (Fe31, 28, 25). Little data were obtainable about the Lower Freeport in the valley of Little Mahoning Creek. The outcrop shows as a bloom on Route 236 (Fe8), and on the township road bearing northward (Fe4).

UPPER KITTANNING COAL

As previously discussed in this report, the Upper Kittanning coal appears to be erratic in occurrence in the Smicksburg quadrangle. Only a few openings have been made on it and it generally is missing

at its expected position in the section where the horizon crops out. It, also, was found to be thin or missing in most of the diamond drill holes that penetrated the horizon. However, the bed is developed locally, and is fairly persistent. Also, coal at the horizon of the Upper Kittanning, or from 80 to 120 feet below the horizon of the Upper Freeport, is indicated on many of the logs of wells drilled in the quadrangle in search for natural gas (see table 5). Even though the bed seemingly does not have value under present commercial mining conditions, its possibility as a future producer should not be ignored.

The known best development of the Upper Kittanning coal in the Smicksburg quadrangle occurs in the northwestern part where, on the Gruver farm, about 1.4 miles south of New Salem (Aa40), the bed has a known total maximum thickness of 99 inches, consisting of an upper bench of 53 inches of bituminous and a lower bench of 46 inches of inferior grade cannel coal, quite similar to a variety called "bird's-eye" (fig. 76, sec. 1). The top of the bed is about 90 feet below the top of the Upper Freeport limestone, which is opened above. The association of cannel coal with the Upper Kittanning is a characteristic of the bed in western Pennsylvania. At one time most of the cannel coal mined in the State came from a small district south of New Bethlehem in the Rural Valley quadrangle, approximately 6 miles to the west. This occurrence is described in some detail by Platt.[58] The development of the Upper Kittanning in the Gruver farm may possibly be in the same channel or channel system as that south of New Bethlehem. Only a small part of the mine could be examined, but information obtained from near-by residents indicates that the bed occurs in a pocket; also that the coal has been worked for many years and is nearly exhausted.

North of Timblin, near the head of Eagle Run, a coal bed having a maximum thickness of a little over 60 inches was being worked for local consumption (Ba14). For reasons stated previously in this report, this bed is correlated as Upper Kittanning. The development of the bed apparently is local. Only a small part of the mine was accessible, but the operator at the mine supplied the information that the coal becomes thinner into the hill. A variable thickness of bony lies on top of the coal; dark shale makes the roof, and an unknown thickness of slate is under the coal. The section of the bed shown graphically on figure 76, section 2, was obtained a short distance in from the entry to the mine. In July 1944 the Hallett Coal Co. was making preparations to strip-mine this coal. An analysis of a crop sample showed 5.2 percent ash and 1.08 percent sulphur (see table 3).

The Upper Kittanning makes a fair bloom where it crops out on the hard-surface road north of Timblin (Ba21). Diamond core drilling in the area about Ringgold disclosed that the coal is thin or missing. The upper Kittanning was tested on the Parr farm about 1.5 miles west of Oliveburg and revealed the following section: Roof, shale; bony, 10 inches; laminated coal, 6 inches; coal, 32 inches; bony, 2 inches plus. An analysis of this coal showed 10.4 percent ash, and 1.25 percent sulphur. (For complete analysis, see table 3). On

[58] Platt, W. G., Armstrong County: Pennsylvania 2d Geol. Survey Rept. H5, 1880, p. 176.

the improved road north of Valier (Eb53) the Upper Kittanning coal is 24 inches thick (fig. 76, sec. 6), and is exposed with its underlying limestone. Northeast of Hamilton where the Lower Freeport had been strip-mined, the Upper Kittanning lies about 25 feet below that bed and is 24 inches thick. An opening was made on the same coal and some of it was taken out for house coal on the Watts or Elkins farm about 1.2 miles southwest of Porter (Bb48). The section in this bank shows a shale roof, 20 inches of fairly good coal, 9 inches of bony, and plastic clay (fig. 76, sec. 4). The face cleat of the coal bears N.55°W. and the butt N.40°E.

A coal occurring at the horizon of the Upper Kittanning was being mined for local use on the Good farm about 1.4 miles north of Dayton (Ac25). The cap rock is sandstone, which rolls into the coal and reduces its thickness at some places. The full thickness of the coal is 48 inches. It is topped by up to 12 inches of bony, over which is a variable thickness of dark shale. In contact with the coal at the base is one inch of slate, under which is an unknown thickness of carbonaceous clay (fig. 76, sec. 3). The face cleat of the coal bears N.55°W., the butt cleat is indistinct.

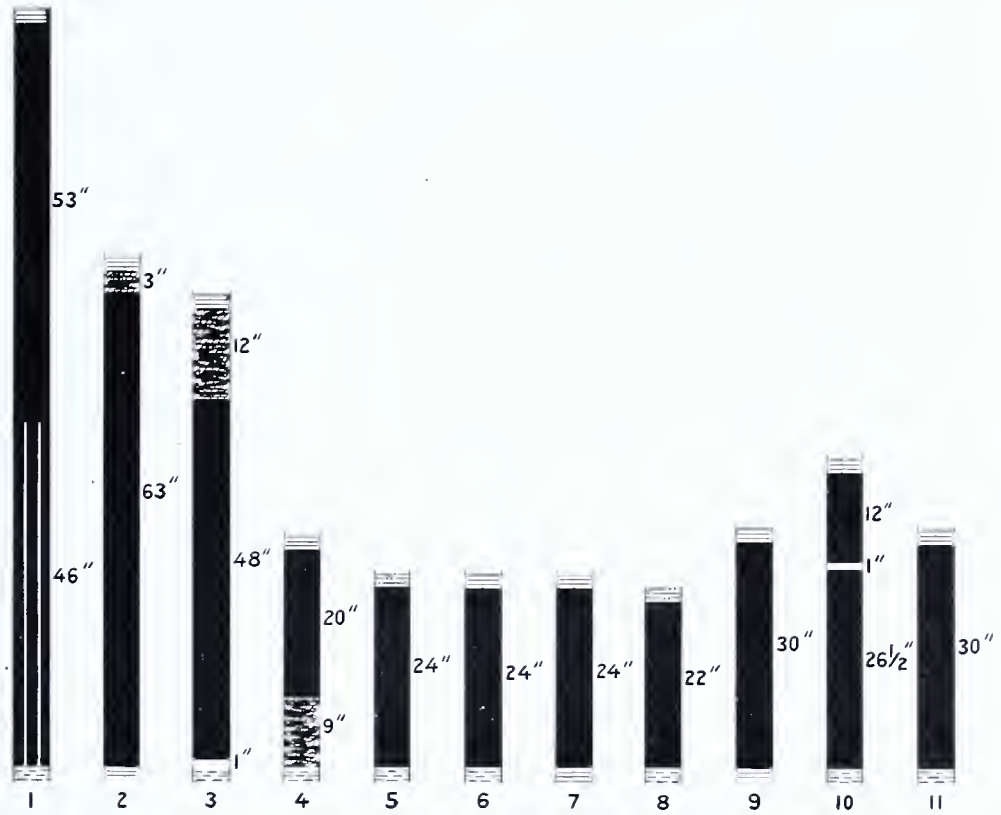


Figure 76. Sections of Upper Kittanning coal.

1. Aa40, country bank, Gruver farm. 2. Ba14, country bank. 3. Ac25, custom bank, Good farm. 4. Bb48, country bank. 5. Bc24, outcrop. 6. Eb53, outcrop. 7. Diamond drill hole No. 101. 8. Fe34, country bank, Streams farm. 9. Ff2, outcrop. 10. Ff24, country bank. 11. Country bank, south of Marion Center.

The Upper Kittanning is exposed and is 24 inches thick in the bluff along the Baltimore & Ohio Railroad, 1.3 miles southwest of Loop (Bc24). About 6 feet of sandy shale is over the coal, which in turn is overlain by sandstone. Underlying the coal is 24 inches of hard gray plastic clay, and it is underlain by sandstone (fig. 76, sec. 5). A few prospect pits had been dug on the Upper Kittanning and some thin outcrops were noted elsewhere in the valley of Mahoning Creek, and the indications are that the coal has little value. The horizon is, for the most part, below drainage in the valley of Little Mahoning Creek.

Although it has relatively little importance at the present, the Upper Kittanning may have some future economic value in the Marion Center district. The coal appears to be fairly persistent and has been worked in a small way at a few places. Its average depth below the horizon of the Upper Freeport is approximately 90 feet.

Blooms mark the outcrop of the Upper Kittanning on the improved roads a little east and south of Marion Center (Ff13, Ef10). The coal with its underlying limestone apparently had been worked on the east side of Route 480 about one mile south of Marion Center (Ff25), but the thickness of the respective beds could not be determined. A short distance in the Indiana quadrangle on the east fork of the township road south of Marion Center, there is a caved country bank on the Upper Kittanning. The farmer who mined the coal said that it has a thickness of 30 inches. The mine is roofed by shale and the floor is composed of 15 inches of clay under which is 5 feet of limestone (fig. 76, sec. 11). An opening on the Upper Kittanning had been made on the Avery farm about 1.5 miles southeast of Marion Center (Ff29) and the following section was reported: Roof, shale; cannel shale, 6 inches; coal, 30 inches; clay, 22 inches; and limestone, 5 feet. The same coal is exposed on the small stream 0.4 of a mile north of the Avery bank (Ff24), where it has a thickness of 38½ inches, and contains a ½-inch binder 12 inches from the top. The bed is topped by black shale and underlain by hard plastic clay (fig. 76, sec. 10). A caved drift also on the Upper Kittanning is located on the Lowman farm about 0.4 of a mile southeast of Lowman School (Ff22).

A coal taken to be Upper Kittanning was open in a country bank along Pickering Run on the Streams farm 1½ miles northeast from Marion Center (Fc34). The bed in this drift has a thickness of 22 inches. It is roofed by dark, sandy shale and underlain by clay (fig. 76, sec. 8). The bearing of the face cleat is N.55°W. and the butt is N.35°E. This coal crops out on the improved road a little north of Pickering Run (Ff2) and is 30 inches thick (fig. 76, sec. 9).

The Upper Kittanning coal apparently has a minable thickness, as was evidenced by caved country banks on that horizon near the eastern boundary of the quadrangle, south of Little Mahoning Creek (Fe19, 20). It appears that a considerable quantity of coal had been taken out. In July 1944 the coal was being strip-mined in the hill to the north, in the Punxsutawney quadrangle. The Upper Kittanning is either a split bed in this locality or the lower of the two coals here being stripped corresponds to one of the Middle Kittanning coals.

The upper coal is 31 inches thick and has a 2-inch slate binder near the middle. The bed is overlain by at least 30 feet of dark shale. The lower coal is 36 inches thick and is separated from the bed above by 25 feet of shale and platy sandstone.

A small country bank, now closed, is on the outcrop of the Upper Kittanning along the first run west of the boundary of the quadrangle, north of Little Mahoning Creek (Fe5). The Upper Kittanning is 30 inches thick where it appears in the bed of Little Mahoning Creek, about 1.1 miles from the western boundary of the quadrangle (Fe12).

MIDDLE KITTANNING COALS

It was pointed out previously in this report in the discussion of the Middle Kittanning coals that there are at least three coal beds in the interval between the Upper Kittanning and Lower Kittanning coals in the Smicksburg quadrangle. These coals are commonly thin and nonpersistent and, therefore, do not have present commercial value. However, they are thick and persistent enough locally to be of value for domestic fuel supply and are mined for that purpose at various places.

On the "black-top" road along Big Run, about 0.8 of a mile southwest of Oliveburg (Fa21) a coal lying about 145 feet below the horizon of the Upper Freeport was reported to be 28 inches thick. It is overlain by shale and underlain by clay (fig. 77, sec. 1). Farther northwest along the "black-top" road a coal of unknown thickness had been opened at two places (Ea5, 9). This bed is lower in the section or about 25 feet above the Lower Kittanning coal, which lies approximately 245 feet below the Upper Freeport horizon.

A coal 12 inches thick (fig. 77, sec. 2) is exposed on a road about 0.8 of a mile north of Frostburg (Fa22). A test pit dug about one mile northwest of Frostburg (Ea18) disclosed a coal reported to be 49 inches thick (fig. 77, sec. 3). This coal occupies a position about

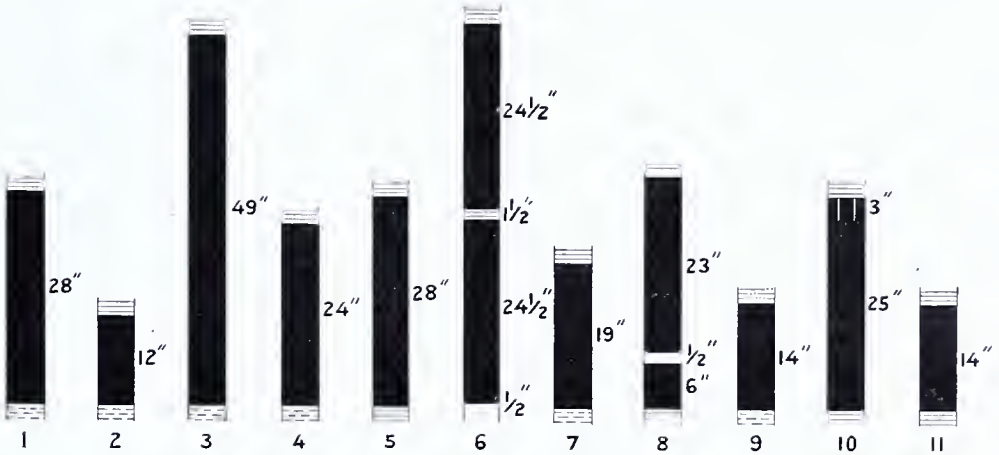


Figure 77. Sections of Middle Kittanning coals.

1. Fa21, country bank. 2. Fa22. outcrop. 3. Ea18, prospect pit. 4. Eb12, country bank. 5. Eb32, country bank. 6. Bb37, country bank. 7. Bc12, outcrop. 8. Bc18, country bank. 9. Bc20, outcrop. 10. Diamond drill hole No. 70. 11. Ff6, country bank

160 feet below the horizon of the Upper Freeport. About 0.9 of a mile south of Frostburg on the east fork of Rose Run (Eb12), a coal 24 inches thick (fig. 77, sec. 4) was encountered in a drift. It occurs approximately 180 feet below the Upper Freeport.

The Middle Kittanning coals crop out as blooms in the vicinity of Hamilton. One of them was being worked in a drift about half a mile east of that place (Eb32) and is 28 inches thick (fig. 77, sec. 5).

Thin blooms mark the outcrop of the Middle Kittanning coals at many places in the Pine Run district. A coal lying approximately 160 feet below the horizon of the Upper Freeport had been opened at a few places in the vicinity of McGregor. The drifts have long been caved, but it was learned from a resident that the bed is a "low" coal. Coal in a caved drift (Ac1) at the boundary of the quadrangle west of Milton is said to be 84 inches thick. It is 40 feet above the Lower Kittanning. The same coal had also been opened about half a mile south (Ae2), but its thickness could not be determined.

On a branch of Foundry Run, about 0.9 of a mile northeast of Milton (Bb37), the coal lying 160 feet below the Lower Freeport had at one time been mined for house use. The farmer who worked the mine said the bed is 50 inches thick, including a 1½-inch parting in the middle (fig. 77, sec. 6). East of Milton on the road along Sugar-camp Run (Bc12), a 19-inch coal crops out (fig. 77, sec. 7). At the confluence of Mahoning and Little Mahoning creeks (Be18), a small country bank discloses 29 inches of fairly good coal, with a 1½-inch parting 6 inches from the base (fig. 77, sec. 8). The bed is 170 feet below the Upper Freeport.

Weathered outcrops indicating thin coals mark the Upper Kittannings in the Mahoning Creek valley eastward. A coal 14 inches thick (fig. 77, sec. 9) is exposed on the road half a mile southwest of Loop (Bc20). In a diamond drill hole (70) a little north of Trade City, a coal was encountered at 143 feet below the horizon of the Upper Freeport. The core showed 28 inches of coal, the upper three inches of which were cannel coal (fig. 77, sec. 10).

A few poorly exposed outcrops were observed of a Middle Kittanning coal in the Marion Center district. A coal 14 inches thick (fig. 77, sec. 11) was noted along Pickering Run (Ff6). At the eastern boundary of the quadrangle about 0.6 of a mile south from Little Mahoning Creek, coal in two closed country banks (Fe17, 18) is 140 feet below the Upper Freeport. Information about the coal in these drifts was not obtainable. A short distance to the northeast in the Punxsutawney quadrangle, a coal at the same horizon had been mined for local consumption and was reported as being 84 inches thick.

LOWER KITTANNING COAL

The Lower Kittanning coal is above drainage in the northwestern part of the Smicksburg quadrangle where it has been elevated by the Sprankle Mills anticline. The Lower Kittanning contributed largely to the total production of coal in the quadrangle. Commercial production from this bed up to and including 1943 is something over 7,000,000 tons, and this was entirely from the Pine Run district.

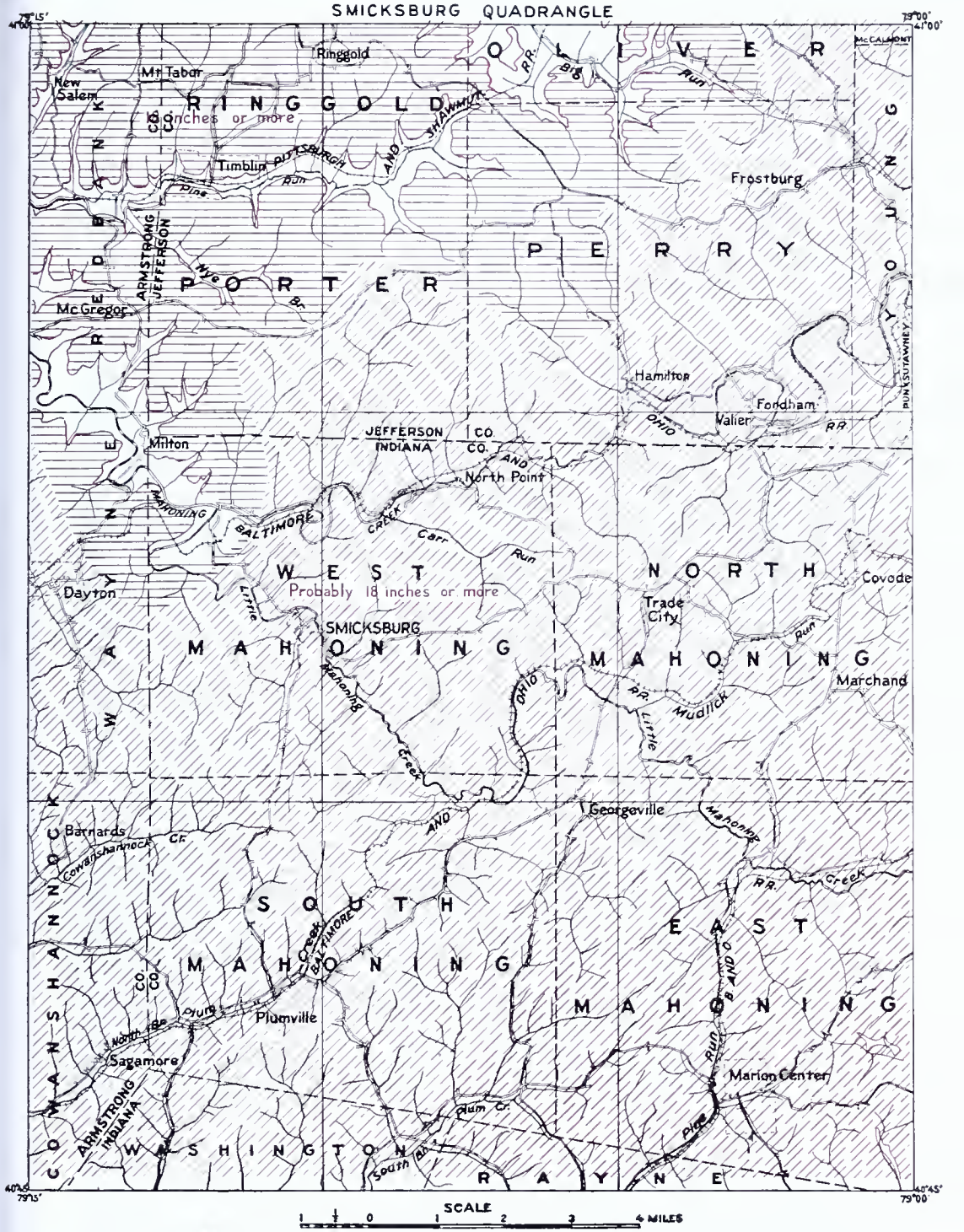


Figure 78. Map showing general distribution and thickness of the Lower Kittanning coal.

In the Pine Run district, the Lower Kittanning coal averages 33 inches thick, the maximum being 42 inches. The better coal is generally in the area adjacent to Pine Run, where it has an ash content ranging from 6 to 8 percent and a sulphur content ranging from

.75 to 1.25 percent. As the mines were advanced toward the Sprankle Mills anticline and Worthville syncline, the coal decreased in quality. Most of the better coal in the district has been mined out. The remaining coal reserves have 10 to 18 percent ash, and 2 to 6 percent sulphur. The district had about reached its economic limit of production when the area was revisited in 1944.

The crop line of the Lower Kittanning extends well up Big Run and its south branch, McCracken Run. A caved drift on the Lower Kittanning a little northwest of where the coal goes under Big Run (Ea6) is reported to have coal 36 inches thick. Northwest from there the coal reportedly becomes thinner. A country bank on the west side of McCracken Run was closed (Da25). Two poor outcrops occur on the east side of the same run (Ea23, 13). At the latter place a prospect pit was said to have revealed 36 inches of coal.

McCracken Run. The outcrop of the Lower Kittanning winds irregularly around the hill west of McCracken Run, rising on the east flank of the Sprankle Mills anticline. The presence of coal is indicated by abandoned country banks (Da9, 11, 28, 27). Country banks also mark the outcrop on the hillside to the west (Da31, 56). The horizon of the Lower Kittanning is well up in the hill to the north. An opening on the coal on the south side of the hill (Da14) shows 15 inches of coal, topped by 2 inches of bony, and overlain by shale (fig. 79, sec. 3). An active country bank (Da16) about 0.6 of a mile west of the latter place has a rather uniform thickness of 35 inches of coal. The roof is shale and the floor is plastic clay (fig. 79, sec. 2). The face cleat is N.55°W., the butt N.35°E. A bloom of the Lower Kittanning was seen on the abandoned township road to the north (Da1).

The entry to the Mauk mine of the King Coal Co. (Ca18) is situated about 0.4 of a mile west of the west portal of the Mauk tunnel. It is a small pick mine having a workable area of 130 acres and an average daily output of about 40 tons. The Lower Kittanning in this mine has a fairly uniform thickness of 32 inches. It has a dark luster, an irregular fracture, is medium hard, and breaks out into about 60 percent lump. A bone or cannel binder is in the bed near the top and the bottom. These impurities are not cleaned in mining and, therefore, greatly increase the percentage of ash. Nonpersistent lenses of sulphur also are in the coal. The roof commonly is shale up to 35 feet thick. A few inches of bone is in contact at the top at some places and about five feet of plastic clay makes the floor. A typical section of the bed is shown on figure 79, section 5. This mine was opened in 1922 and up to and including 1943 produced a little over 367,000 tons.

The Maurer mine (Ca19), operated by the Sprankle Mills Coal Co. of Worthville, is situated a little to the south of the Mauk mine. It began producing Lower Kittanning coal in 1920 and up to and including 1943, the reported total production is approximately 315,000 tons. It, also, is a hand pick mine with an average daily output of 60 tons and a workable area of 248 acres. The character of the coal

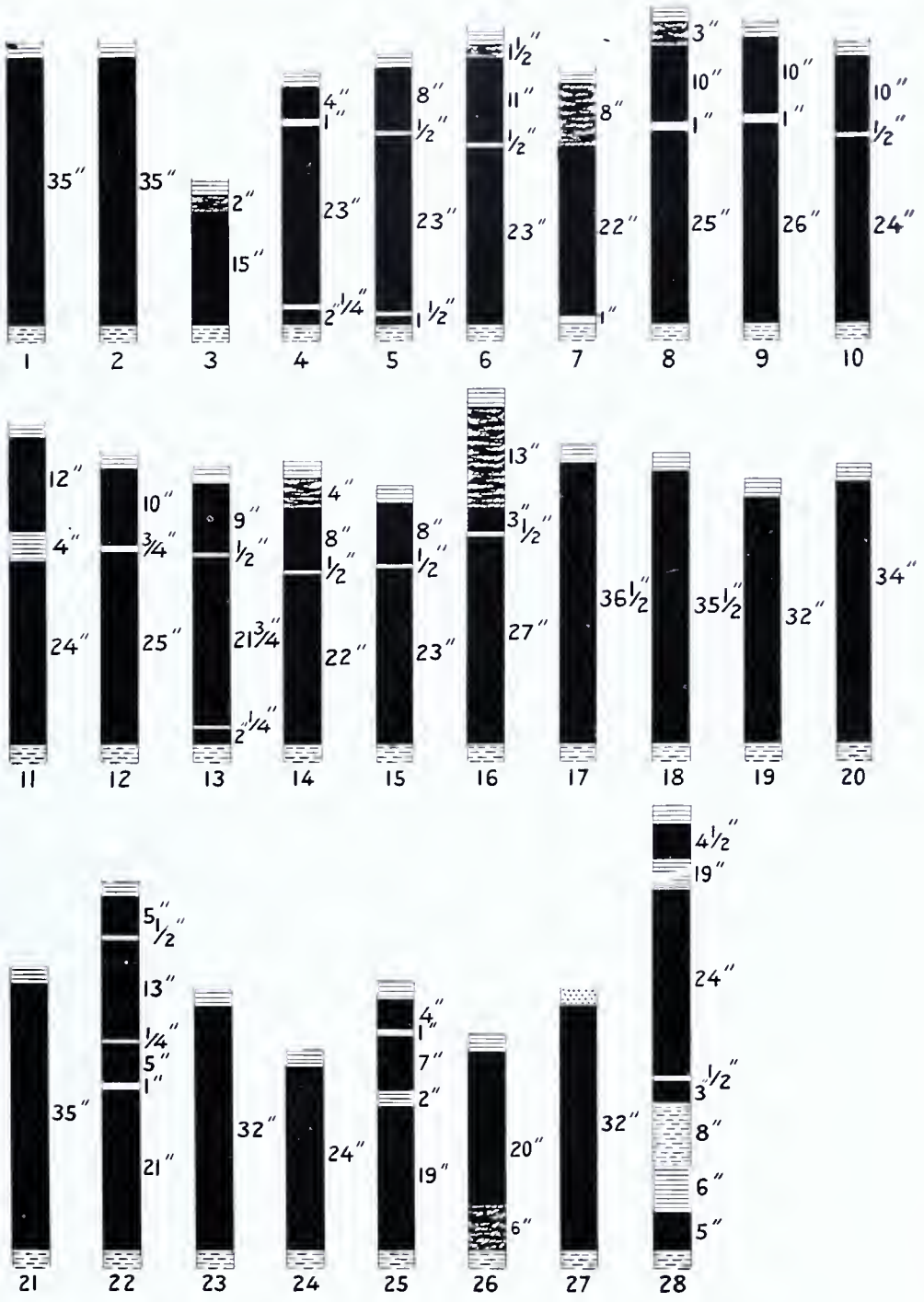


Figure 79. Sections of Lower Kittanning coal.

1. Diamond drill hole No. 2. 2. Da16, country bank. 3. Da14, country bank. 4. Ca19, Maurer mine. 5. Ca18, Mauk mine. 6. Ca20, St. Marys Sewer Pipe Co. No. 1 mine. 7. Da50, country bank. 8. Ca30, Dora mine. 9. Ca30, Dora mine. 10. Ca27, outcrop. 11. Ba51, country bank. 12. Ba48, Corbett No. 2 mine. 13. Ba39, Ringgold mine. 14. Aa50, McGregor No. 2 mine. 15. Aa50, McGregor No. 2 mine. 16. Ab25, country bank. 17. Ab27, country bank. 18. Bb12, custom bank. 19. Ab52, outcrop. 20. Ca42, country bank. 21. Ac31, country bank. 22. Ac32, country bank. 23. Diamond drill hole No. 4. 24. Diamond drill hole No. 45. 25. Diamond drill hole No. 70. 26. Diamond drill hole No. 78. 27. Diamond drill hole No. 110. 28. Diamond drill hole No. 126.

in this mine is quite similar to its occurrence in the Mauk mine, but it averages a little less in thickness (fig. 79, sec. 4). The mine has a recovery of 75 percent.

Country banks mark the outcrop of the Lower Kittanning elsewhere in this locality (Ca29, Da50, 51). All but one of these were inactive and their entries were closed. In the one still accessible (Da50), the coal is reduced to 22 inches thick. It is topped by 8 inches of bony and roofed by shale (fig. 79, sec. 7). The face is N.55°W. and the butt is N.35°E. The Lower Kittanning was worked in country banks on the east side of Middle Branch (Ca33, 41, 42), but only one of these drifts was open (Ca42) wherein the coal is 34 inches thick. It has shale on top and plastic clay under (fig. 79, sec. 20). The face cleat trends N.55°W. and the butt N.45°E.

The St. Marys Sewer Pipe Co., having headquarters at St. Marys, operates a small pick mine (Ca20, 35) on the Lower Kittanning a little southwest of the Maurer mine. From the time this mine began operations in 1919 and up to and including 1943, it produced a little over 533,000 tons; the average daily output being 100 tons. The coal has a fairly uniform thickness of a little over 30 inches. In contact at the top is an average of 1½ inches of bone which is "burned" to the coal and a ½-inch bone binder occurs about 11 inches from the top. The immediate roof is shale and the floor is clay of unknown thickness. The coal has predominantly bright luster, it is relatively soft, and mines out in about 40 percent lump. The recovery is indicated as 80 percent. A typical section of the coal bed is shown graphically on figure 79, section 6.

Dora. A mine operated by the Dora Coal Co. and called the Dora mine (Ca30) is situated a little to the northeast of the place by that name. This is a machine and pick mine and is reported to have worked out approximately 800 acres of Lower Kittanning. Operations began in 1918 and the indicated total production up to and including 1943 is about 846,000 tons. The average daily output of the mine is 150 tons. The normal thickness of the coal is 36 inches. It commonly contains a one-inch bone or cannel binder 8 to 12 inches from the top and on top of the coal is from 4 to 10 inches of bony or draw slate, which parts free from the roof and the coal. The immediate roof is shale up to 30 feet thick and the floor is 3 to 5 feet of plastic clay. Typical sections of the bed are shown on figure 79, sections 8, 9. The coal has an irregular fracture and mines out into 60 percent lump. The recovery is 80 percent. A composite analysis of two mine samples shows 6.9 percent ash, and 1.2 percent sulphur. For complete analyses, see tables 1, 2.

The outcrop of the Lower Kittanning and its associated beds is well displayed in the railroad cut just west of Dora (Ca27). The coal is there 34 inches thick and contains a ½-inch binder ten inches from the top. Shale is over and plastic clay is under the coal (fig. 79, sec. 10).

Lower Kittanning coal was mined on a relatively large commercial basis on Taylor Run at a little mining town called Sunrise, where the Markle Buller Coal Co. of Timblin operated their No. 1 (Ca25) and

No. 2 (Ca24) drift mines. Production was begun in 1921 and as of 1936 the reported total production was approximately 1,159,000 tons. The average thickness of the seam is 33 inches and it generally maintains its character for the area, having binders near the top and bottom. Bony is commonly lacking at the top. The roof is shale; soft plastic clay of unknown thickness is under the coal. A composite analysis of three samples shows 5.1 percent ash and 0.8 percent sulphur.

A small country bank (Ba51) was working Lower Kittanning coal on the opposite side of Pine Run south of the Markle Buller mines. A section of the bed obtained in this bank showed 36 inches of coal, with a four-inch shale parting 12 inches from the top. Shale makes the roof and clay the floor (fig. 79, sec. 11). The face cleat bears N.60°W., the butt cleat N.40°E.

The Corbett Mining Co's. No. 2 mine, which worked the Lower Kittanning coal, is on the south side of Pine Run at the little mining town called Corbettville (Ba47, 48). This mine was in operation periodically during the years 1917, 1918, 1927, and 1928. Its total production was a little over 30,000 tons. The normal thickness of the coal is 36 inches, but it is reportedly very irregular and the coal is inferior in quality. A normal section of the bed is shown on figure 79, section 12.

Ringgold. The Ringgold mine, operated by the Allegheny River Mining Co. is about one mile northeast of Timblin. The mine (Ba39) was opened and coal was shipped in 1920. Mining operations were almost continuous since that time, and up to and including 1943 the indicated total production is about 2,274,000 tons. Approximately 2,500 acres have been worked out. Lower Kittanning coal in this mine ranges from 26 to 42 inches thick. The normal range is 32 to 34 inches. Its character is generally similar to its occurrence elsewhere in this area. The bone or cannel binder near the top is rather persistent (fig. 79, sec. 13). Shale commonly makes the roof and plastic clay the floor. The earlier mined coal was fairly good in quality, having 8 to 16 percent ash, and from 0.75 to 1.25 percent sulphur. As operations advanced toward the Worthville syncline, the ash and sulphur content progressively increased. Most of the coal economically recoverable at present standards has been removed. There is, however, a considerable unmined area not adequately tested by diamond drilling, but what drilling has been done shows faults, rock rolls, bad roof conditions, and generally inferior coal. A diamond drill hole put down about half a mile northwest of Ringgold showed a core of Lower Kittanning coal 40 inches thick. Analysis of the coal showed 10.1 percent ash and 2.76 percent sulphur (See table 3).

A little southwest of Timblin, a mine was opened on the Lower Kittanning by the Mill Coal Co. (Ba41) in 1928 and was reportedly abandoned the same year. Its total production was reported as about 36,000 tons. The coal is irregular and poor in quality.

A mine on the Lower Kittanning, called the McGregor No. 2 (formerly the McCall mine), is on the north side of Pine Run about one mile west of Timblin. Approximately 847,000 tons have been

recovered from the mine (Aa50), which was opened about 1924; and about 1,000 acres have been mined out. The coal is rather regular and has a normal average thickness of 30 inches. It is medium in quality. A few inches of bony, which parts free from the roof and the coal, is present at some places. Shale up to 35 feet thick is the roof. Bad roof conditions exist in some parts of the mine. Excepting a ½-inch binder near the top of the bed, which is not cleaned from the coal, the bed is generally free from visible impurities. A typical section of the coal bed is shown on figure 79, section 14. Plastic clay up to 9 feet thick underlies the coal.

Figure 80. McGregor No. 2 mine, west of Timblin.

The Lower Kittanning appears to be persistent in occurrence and has a known maximum thickness of 36 inches in Red Bank Township, north of Pine Run. A caved country bank (Aa60) is situated a little to the southeast of the McGregor No. 2 mine. A bloom of the coal was noted on the road a short distance to the northeast (Aa61) and the coal is at least 30 inches thick where its outcrop shows on the road to the west (Aa59). The Lower Kittanning makes a good bloom (Aa51) and is underlain by soft plastic clay on the first road west of the McGregor No. 2 mine. A custom bank on the Lower Kittanning on the stream a little northwest (Aa52) has coal 36 inches thick. The coal shows as a bloom in the lane about 0.4 of a mile west of the custom bank (Aa44). Blooms were seen also a short distance up Sugarcamp Run (Aa41, 54) and farther up the run the Lower Kittanning had been opened where its thickness is said to be 32 inches (Aa36). The crop line of the Lower Kittanning follows along

Mudlick Run and was located by abandoned country banks (Aa1, 7, 9, 13, 15, 26, 56). The coal in these drifts is said to range from 30 to 36 inches thick.

The Rose and McGregor Coal Co's. Charleston No. 2 mine is on the south side of Pine Run near the western boundary of the quadrangle (Aa57, 58). It formerly was operated by the Charleston Coal Co. The mine is entered in two drifts well up on the hillside. It has a very large tract of workable Lower Kittanning coal, much of which lies in the Rural Valley quadrangle. The mine was opened in 1920 and up to 1935, when operations ceased, about 800 acres had been mined out and approximately 771,000 tons produced. The coal has an average thickness of 35 inches, is of medium quality, containing 8 to 10 percent ash and 2 to 3 percent sulphur. Lenses and balls of sulphur are scattered throughout, and a rather persistent ½-inch sulphur binder occurs about four inches from the bottom. An average of about three inches of bony is commonly present on top, which comes down with the coal in mining. The roof is shale, the floor is plastic clay of unknown thickness.

Nye Branch. The outcrop of the Lower Kittanning coal is just above drainage and extends almost three miles up Nye Branch, or to a short distance east of the axis of the Sprankle Mills anticline. Presence of the coal is indicated by country banks (Ab13, 17, 18, Bb11, 12, 21); all but one of them were inactive and inaccessible. In the one still being worked (Bb12) the coal is 35½ inches thick and is generally free from visible impurities. The mine is roofed by shale and floored by plastic clay (fig. 79, sec. 18). Bearings taken on the face and butt cleats of the coal indicated N.60°W. and N.40°E., respectively.

The crop line of the Lower Kittanning extends from the Rural Valley quadrangle, along a nameless run to a point a little west of the improved road that trends northward from McGregor. The coal in this locality had been opened in four country banks (Ab24-27). The drift along the north side of the township road (Ab25) could be entered and a section of the bed was obtained showing 30 inches of coal having a ¼ to ½-inch binder three inches from the top; on top of the coal is up to 13 inches of bony. The roof of the mine is shale, and the floor is plastic clay (fig. 79, sec. 16). The face of the coal bears N.55°W. and the butt N.30°E. Lower Kittanning was being mined for custom trade toward the headwater of the run (Ab27) where the thickness of the bed has increased to 36½ inches, and bony is lacking at the top. The roof of the mine is shale and the floor is plastic clay (fig. 79, sec. 17). The face cleat is N.50°W. and the butt N.45°E.

Milton. Elevated by the Sprankle Mills anticline, the horizon of the Lower Kittanning is in the upland in the area lying generally west of Milton. Information about the coal in this area is meager. It was opened at only a few places, but as was observed from caved openings and weathered outcrops, the coal appears to be generally present and probably has minable thickness. The coal in this area

seems, therefore, to merit exploration as a future reserve. A considerable amount of Lower Kittanning apparently had been removed in a country bank, now caved (Ab36), on the small stream southwest of McGregor. An opening on the coal had been made north of Mahoning Creek near the western border of the quadrangle on the Lloyd farm where the coal is said to be 28 to 36 inches, with 5 to 6 inches of bony on top. Poor exposures of the coal were seen on the road going generally southeastward (Ab40, 41, 44, 46) and a caved bank on the Travis farm on the north side of the road (Ab45).

An excellent exposure of the Lower Kittanning and its underclay was observed on the road connecting McGregor and Milton, where it crosses the point of a hill (Ab52). The coal there is 32 inches thick and overlain by dark shale (fig. 79, sec. 19). An abandoned country bank is just a little to the east of the exposed outcrop (Ab51) and another caved bank (Ab49) is up the little run to the northeast.

Figure 81. Lower Kittanning coal and underclay, northwest of Milton.

The outcrop of the Lower Kittanning extends about 1.4 miles up Foundry Run, which enters Mahoning Creek at Milton. Blooms of the coal were noted on the road along the south side of the run (Bc1, Bb40) and abandoned banks are on the north side of the run (Ac8, Ab50, Bb38). Lower Kittanning on the west side of Mahoning Creek is indicated by blooms (Ac7, 3) and caved country banks (Ac4, 5) along the road west from Milton. The Lower Kittanning crops out as a bloom on the Milton-Dayton road on the south side of Mahoning Creek (Ac21), and a caved drift is in the ravine (Ac23). The coal in this locality is reported to be 28 inches thick.

Descending on the southeast flank of the Sprankle Mills anticline, the Lower Kittanning goes below drainage at the confluence of Mahoning and Little Mahoning creeks. A small opening on the coal was made on the north side of Little Mahoning Creek, east of Dayton (Ac32) where the outcrop is just above drainage. The coal there has a total thickness of 44 inches, but contains 3 thin binders in its upper part. Dark shale is over and sandy clay is under the coal (fig. 79, sec. 22). The face cleat bears N.45°W. and the butt N.35°E. About half a mile to the north (Ac31), the Lower Kittanning is being taken out for house coal. The bed is 35 inches thick and is free from visible impurities. The roof is dark shale, and the floor is plastic clay (fig. 79, sec. 21). A bearing on the face cleat indicates N.60°W.; the butt is indistinct.

A test pit reported to have been dug a little to the east of the junction of Mahoning and Little Mahoning creeks found 39 inches of Lower Kittanning coal at a depth of 10 feet.

On the north side of Mahoning Creek about 0.3 of a mile northwest from where the creeks join, the Lower Kittanning had been worked in a small drift (Bc16). Early in 1944, the coal was strip-mined for approximately 1,000 feet along the small stream. The cut has an average width of about 25 feet. The coal ranges from 27 to over 30 inches thick and has a shale parting 6½ inches from the top. In contact with the coal at the top is an average of four inches of bony, over which is up to 15 inches of draw slate. The bed contains lenses of mother coal up to 2 inches thick, and sulphur streaks are scattered throughout. At least 24 inches of plastic clay is under the coal. Above the coal is a maximum of 15 feet of dark shale containing iron carbonate concretions and irregular lenses of limonite. The face cleat bears N.70°W.; the butt is indistinct. An analysis of the coal obtained from the operators of the stripping indicates 8.7 percent ash and 2.34 percent sulphur. (See table 3.)

Pickering Run. In the southeastern part of the Smicksburg quadrangle along Pickering Run, northeast of Marion Center, a coal occurring approximately 200 feet below the horizon of the Upper Freeport probably is the Lower Kittanning. The outcrop, which is marked by a bloom and a caved opening (Ff8, 7), forms an elongated fenster on the northwest flank of the Richmond anticline. A coal crops out along a nameless run in the extreme southeast corner of the quadrangle (Ff34, 39). It also occupies a position about 200 feet below the Upper Freeport horizon and, therefore, is believed to be the Lower Kittanning. The thickness of the coal at those places could not be ascertained. The nearest area where information about the Lower Kittanning is available is in the Richmond district in the Punxsutawney quadrangle, where Ashley[59] reports that the Lower Kittanning coal has a range in thickness from 18 to 36 inches.

Diamond drill tests have been made on the Lower Kittanning elsewhere in the Smicksburg quadrangle, particularly where the horizon is well below drainage. The cores of the coal obtained from those tests are shown graphically on figure 79, sections 23 to 28.

[59] Ashley, G. H., Geology and mineral resources of the Punxsutawney quadrangle, Pa.: Pennsylvania Topog. & Geol. Survey Atlas No. 65, p. 93, 1926.

COAL RESERVES

In the following table are shown the coal reserves in the Smicksburg quadrangle before mining. The computation of these reserves was largely an abstract problem. The term original deposit, as customarily used in other reports, is avoided here because in a strict sense an appreciable amount of the coal originally deposited has been eroded by the present streams. The areas in the townships (within the quadrangle) underlain by the horizon of the principal coal beds (Upper Freeport, Lower Freeport and Lower Kittanning) was determined by planimeter on the topographic map, whereon were plotted the outcrops of the respective beds.

The column headed "areas underlain by coal of minable thickness" gives areas wherein information was obtained on a given coal bed at numerous and reasonably well-distributed points, and it could be inferred with some degree of safety that the bed is continuous and maintains a fairly uniform thickness between the points where the character of the bed is known. The column headed "areas probably underlain by coal of minable thickness" gives areas wherein points of information on a given coal are sparse and poorly distributed, but the general indications are that coal probably is persistent, and although irregularities are suspected, adequate exploration may prove relatively large areas of minable coal.

In determining the average thickness of the bed for the respective townships, only the net coal in the measured sections was used; i. e., bony was not considered part of the bed, and where a thick bench of coal was separated from the main bench by a thick parting, the thinner bench was excluded. Investigations in the field show that, although the principal coal beds are thick and persistent in some localities, they generally tend to be irregular. In some places a coal may be thinner or thicker than the measurement given. The U. S. Geological Survey[60] uses a formula for evaluating coal under lands where measurements indicate a rather wide range in thickness of a bed. This formula seemed applicable and was employed in computing a conservative, yet fair estimate, of the coal reserves in the Smicksburg quadrangle. Briefly stated, the formula is as follows: A more probable thickness is obtained by multiplying the average of the measurements by $\left(1 - \frac{SD}{S}\right)$, in which S is the sum of all the measurements and SD is the sum of the numbers obtained by subtracting from the average each measurement below it or subtracting the average from each measurement above it.

In computing the coal tonnage, 97,000 tons per inch of bed per square mile was used. This constant figure is based on a specific gravity of 1.35. An estimate of coal mined out and lost, and coal recoverable could not be made for the quadrangle because the workings of some of the larger commercial mines extend into adjacent quadrangles and mine survey maps were not obtainable.

[60] Smith, G. O., The Classification of the Public Lands: U. S. Geol. Survey Bull. 537, p. 87, 1913.

Table 6. Coal Reserves in the Smicksburg Quadrangle Before Mining

Townships, coal beds	Area underlain by horizon of coal bed	Area underlain by coal bed of minable thickness	Average thickness	Tonnage	Area probably underlain by coal bed of minable thickness	Average thickness	Tonnage	Total tonnage	Net tonnage
	Square miles	Square miles	Inches	Short tons	Square miles	Inches	Short tons	Short tons	Short tons
Cowanshannock Twp.									
Upper Freeport	9.97	8.72	40	33,833,000				33,833,000	21,992,000
Lower Freeport	10.06								
Lower Kittanning	10.06				10.06	19	18,541,000	18,540,000	12,051,000
East Mahoning Twp.									
Upper Freeport	21.93	.85	38	3,133,100				3,133,000	2,036,000
Lower Freeport	25.89	1.26	26	325,000	4.41	26	11,122,000	11,447,000	7,441,000
Lower Kittanning	30.41				30.39	19	56,009,000	56,001,000	36,400,000
McCalmont Twp.									
Upper Freeport	.03								
Lower Freeport	.06	.06	50	291,000				291,000	89,000
Lower Kittanning	.26				.26	19	480,000	480,000	312,000
North Mahoning Twp.									
Upper Freeport	23.31								
Lower Freeport	24.75	4.58	44	19,547,000				19,547,000	12,705,000
Lower Kittanning	25.97				25.97	19	47,836,000	47,836,000	31,093,000
Oliver Twp.									
Upper Freeport	.05								
Lower Freeport	.37	.37	39	1,361,000				1,361,000	885,000
Lower Kittanning	4.64	2.35	24	5,471,000	1.69	19	3,115,000	8,585,000	5,360,000
Perry Twp.									
Upper Freeport	12.36								
Lower Freeport	16.46	16.40	40	63,632,000				63,632,000	41,361,000
Lower Kittanning	28.35	18.11	25	43,917,000	10.24	19	18,872,000	62,789,000	40,861,000
Porter Twp.									
Upper Freeport	8.7	5.08	39	19,218,000				19,218,000	12,502,000
Lower Freeport	11.41	8.91	30	25,928,100	2.5	30	7,275,000		
Lower Kittanning	16.09	9.6	27	25,142,000	6.49	19	11,961,000	37,103,000	24,117,000
Rayne Twp.									
Upper Freeport	2.95	.24	27	629,000				629,000	409,000
Lower Freeport	3.41	.72	26	1,816,000				1,816,000	1,180,000
Lower Kittanning	3.61				3.61	19	6,653,000	6,653,000	4,324,000
Redbank Twp.									
Upper Freeport	1.65	1.52	39	5,711,000				5,711,000	3,712,000
Lower Freeport	3.19				2.43	29	6,836,000	6,834,000	4,442,000
Lower Kittanning	7.68	7.68	30	22,349,000				22,349,000	14,726,000
Ringgold Twp.									
Upper Freeport	4.00	3.39	40	13,153,000				13,153,000	8,549,000
Lower Freeport	5.4				4.81	29	13,530,000	13,530,000	8,794,000
Lower Kittanning	8.88	8.88	26	22,655,000				22,655,000	14,726,000

Table 6. Coal Reserves in the Smicksburg Quadrangle Before Mining —Concluded

Townships, coal beds	Area underlain by horizon of coal bed	Area underlain by coal bed of minable thickness	Average thickness	Tonnage	Area probably underlain by coal bed of minable thickness	Average thickness	Tonnage	Total tonnage	Net tonnage
	Square miles	Square miles	Inches	Short tons	Square miles	Inches	Short tons	Short tons	Short tons
South Mahoning Twp.									
Upper Freeport	27.95	5.4	35	18,333,000				18,333,000	11,916,000
Lower Freeport	28.53								
Lower Kittanning	29.02				29.02	19	56,684,000	56,684,000	36,845,000
Washington Twp.									
Upper Freeport	7.39	3.10	36	10,825,000				10,225,000	6,646,000
Lower Freeport	7.39								
Lower Kittanning	7.39				7.39	19	13,620,000	13,620,000	8,853,000
Wayne Twp.									
Upper Freeport	6.51	2.81	39	10,631,000				10,631,000	6,910,000
Lower Freeport	6.98				3.18	29	8,945,000	8,945,000	5,814,000
Lower Kittanning	8.58	2.17	30	6,315,000	6.41	19	11,814,000	18,128,000	11,783,000
West Mahoning Twp.									
Upper Freeport	22.03	3.38	30	9,836,000				9,836,000	6,390,000
Lower Freeport	24.05	8.38	30	24,404,000	2.11	30	6,140,000	30,544,000	19,854,000
Lower Kittanning	28.78	3.22	30	9,370,000	25.56	19	47,087,000	56,457,000	36,697,000
Young Twp.									
Upper Freeport	3.07								
Lower Freeport	3.93	2.36	51	11,675,000				11,675,000	7,589,000
Lower Kittanning	5.36				5.36	19	9,878,000	9,878,000	6,421,000

NATURAL GAS

History and Development

Natural gas is produeed almost entirely from sandstone, ealled "sand" by the drillers.

Large quantities of natural gas were wasted in the early days of the oil industry. When its adaptability as an ideal fuel for industrial and domestie use was reeognized, its development was very rapid. As the demand inereased, older fields were expanded to their productive limits and new territories were explored. In reeent years, the supply barely meets the demand and there are relatively few areas remaining in possible gas-produeing territory that have not been tested to some extent.

The Smieksburg quadrangle lies near the eastern limit of natural gas oeeurrenee in the State. The earliest well that eneountered gas nearest to this area was drilled in 1873 at MeCrea Furnace along Mahoning Creek, about two miles west of the boundary of this quadrangle. The first known well drilled within the quadrangle was at

Marion Center in 1891, but wells probably were drilled earlier. Gas was discovered near New Salem in 1894, near Oliveburg in 1920, and North Point in 1924. Drilling in the quadrangle gained impetus thereafter.

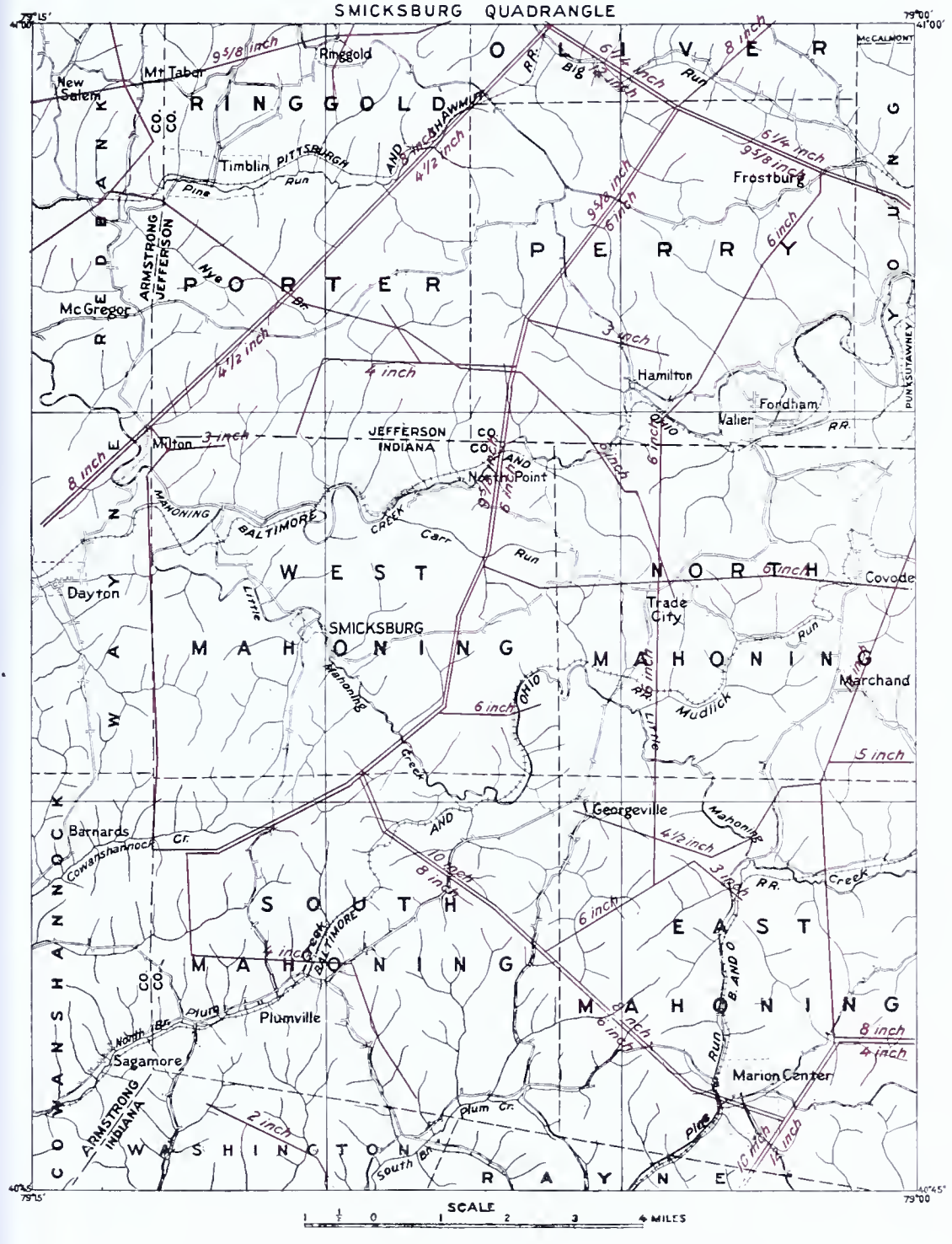


Figure 82. Map showing natural gas pipe lines.

Large quantities of natural gas have been produced in this area, but the yield is well past its prime. However, drilling continues to produce gas. More than 1,100 wells have been drilled in the quadrangle. About 65 percent were productive; of those about 20 percent are practically exhausted, and about 75 percent of the latter have been abandoned. Approximately 22 percent of all the wells drilled are dry or produced little gas (''show gas'') and the history of 13 percent is not known. Oil has not been encountered in commercial quantities. It was reported as a ''show'' in a few wells and usually occurs in the ''sands'' above the Catskill red beds.

Natural gas pipe lines cross the quadrangle in all directions, forming a veritable network. They range from 2-inch lines at the wells to 12-inch main lines. The main pipe line system of one of the larger gas companies is shown on figure 82. Most of the gas is piped to the larger industrial centers to the west.

Figure 83. Drilling rig and equipment.

Drilling Method

The standard rig or derrick, which was developed in Pennsylvania, is commonly used for drilling gas wells in this area. It is constructed of wood or steel and is from 60 to 80 feet high. The drilling rig equipment (fig. 83) consists essentially of A, bailer or sand pump; B, band wheel; C, bull-wheel; D, calf wheel; E, crown block; F, crown pulley; G, drilling cable; H, pitman; I, samson post; J, sand line; K, sand-pump pulley; L, sand reel; M, temper screw; O, walking-beam; and P, wrist pin. Internal-combustion engines, from 50 to 100 horse-power, have generally replaced steam-power; natural gas, piped from the nearest line, is the usual fuel.

Figure 84. Natural gas well drilling rig.

The cable-tool or churn-drill method is employed. The "string of tools" consists of a bit, stem, jars, and rope socket, having a total length of about 40 feet. The "string of tools" is attached to the temper screw, which in turn is attached to the walking beam. The walking beam lifts and drops the tools, the bit cutting the rock by repeated blows. As the hole is deepened, the temper screw is let out. When the temper screw is run out full length, the tools are re-

moved from the hole, the bailer is run in and the hole pumped out. The tools are again run into the hole and drilling is resumed. Some holes have been drilled without casing, but in most wells too much water, or soft material that caves is encountered and a variable length of casing is required.

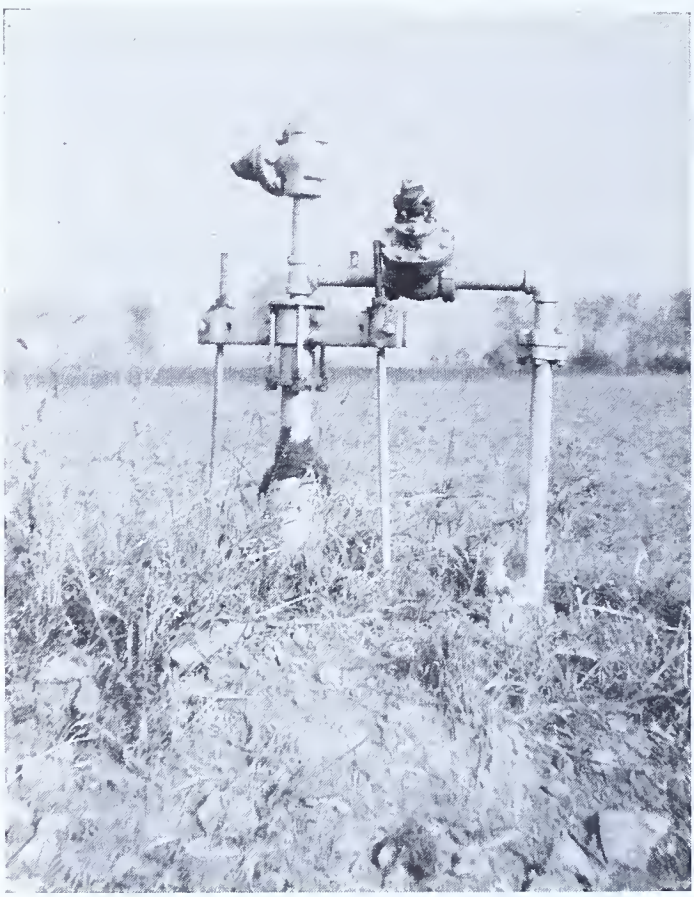


Figure 85. Productive gas well.

Natural Gas Maps

The wells drilled for natural gas are shown on four maps; each map covers one-fourth of the Smicksburg quadrangle (plates 7, 8, 9, 10). The base was constructed from the topographic map of the quadrangle, and includes most of the recent cultural changes. Property lines are as of 1912 and later. These maps are not to be considered as very accurate.

It is the custom of gas operators to name the lease after the owner of the surface or to whom royalty is paid. Most of the names of owners on the original map still are the owners of royalty, and those names appear on the maps in vertical letters. Numerous lease names have since been changed and such known changes are shown in italic. Because in local parlance former owners' names continue in use, they are retained on the maps.

An attempt was made to locate and obtain elevations of wells for which better records were had; and where subsurface structural control was desirable. However, it was impractical to spend much time searching for dry holes and long-abandoned producers. Nature soon conceals the site and most such wells are almost impossible to find without a guide.

Since elevations of many of the wells have not been obtained, and in order to present most of the well data at hand, the depth from the top of the wells to these data such as fresh water, salt water, and gas "pays" are indicated on the maps close to the well symbols. Elevations of bench marks and of road intersections were taken from the topographic map. Drillers' names for the sands wherein the gas pays occur are indicated by symbols, such as M = Murrysville.

The locations of wells were taken from operators' maps and are fixed with respect to property lines; some adjustments have been made from field observations. Wells for which records have been obtained are indicated by numbers; each township or part of a township included in the four maps has a separate series of numbers. Records of these wells may be consulted at the offices of the Topographic and Geologic Survey, or copies will be furnished by request in writing upon payment of a fee of twenty-five cents for records of wells less than three thousand feet deep, and of twenty-five cents additional for each additional thousand feet of well depth covered by such records. When requesting records, indicate township, number, and quarter section of quadrangle.

Origin and Accumulation

The generally accepted theory for the origin of oil and natural gas is that they were formed from the remains of plants and lesser amounts of animal matter that were deposited along with sediments in bodies of fresh or salt water many million years ago. Before burial the organic matter was partially decayed and deoxodized, changing the original matter to oily, waxy, resinous matter. Subsequent burial by thousands of feet of overlying sediments and pressure by crustal movements squeezed and heated the organic matter until it was transformed into carbonaceous products such as coal, petroleum, and natural gas. The difference in character of these resultant products having a common origin is due to the manner in which the source material was originally deposited and to the differences in pressure and heating to which they had been subjected. For a full discussion of the formation of petroleum and natural gas see Clarke's Data of Geochemistry[61].

If the tiny globules of oil and bubbles of gas remained disseminated throughout the shale where they were originally formed from carbonaceous material, present methods of recovery of oil and gas would be impossible. Accumulation into commercial pools is accomplished by migration of the oil and gas with water from point of origin to a porous stratum such as sandstone. The chief factors influencing this movement are: The presusre due to the weight of additional

[61] Clarke, F. W., The data of geochemistry: U. S. Geol. Survey Bull. 770, pp. 744-756, 1924.

sediments, the rocks above being less compacted than those below, and the strong capillary attraction of water. Further segregation of oil, gas, and water is, however, essential to productive accumulation. In flat-lying or only slightly tilted beds, the oil and gas would be forced slowly along by the water and there would be little concentration. In dipping beds, water, oil and gas continue to migrate up the dip until they are arrested either by a change in dip, discontinuance of bed, or lessened porosity. During migration, the water, oil, and gas begin to separate according to their specific gravities; and after having been arrested in a trapped structure, the separation becomes complete, with gas on top exerting pressure in all directions; the oil beneath it being buoyed up by the water at the bottom. It has been found that oil and gas pools occur where some type of closed structure has halted migration of the hydrocarbons and concentrated them.

Composition and Uses

Natural gas is composed of a mixture of gaseous hydrocarbons, methane, ethane, and propane with small amounts of carbon dioxide, nitrogen, and hydrogen sulphide, and in some cases a trace of helium and other rare gases. Methane is nearly always the predominating constituent, representing about 80 percent by volume, while ethane is second with 10 to 20 percent.

Natural gas is classified as either wet or dry, according to its content of gasoline. Wet gas is commonly associated with oil and is generally obtained from the same sand that yields the oil. Dry gas contains chiefly methane and is not often associated with oil-producing sands. It is not known if natural gas from wells in the Smicksburg quadrangle has been analyzed. The following table gives analyses of natural gas from wells in other areas:

Analyses of Natural Gas

County	Sand	Date	Source*	B.t.u. per cu. ft.	Sp. gr. Air = 1	Chemical composition in %						
						N_2	CO_2	O_2	Total paraffin	CH_4	C_2H_6	Total
Armstrong	Fourth	1911	1.	1184	.64	1.5			98.5	81.6	16.9	100
Clarion	Fourth	1911	1.	1703	.57	1.1			98.9	96.4	2.5	100
Clarion	Bradford	1911	1.	1189	.65	1.7			98.3	80.5	17.8	100
Clarion	—	1931	2.	1135	.64	.1	.1	.1	99.7	82.9	16.8	100
Elk	—	1916	3.	1146	.61	.8			99.2	88.0	11.2	100
Forest	Third	1911	1.	1279	.70	1.0			99.0	70.8	28.2	100

* 1. The condensation of gasoline from natural gas. Burrell, G. A., Seibert, F. M., and Oberfell, G. G. U. S. Bureau of Mines Bull. 88, pp. 21-22.
2. Courtesy of J. French Robinson. Peoples Natural Gas Company.
3. Analyses of natural gas from 31 cities in the United States, Burrell, G. A., and Robertson, I. W.: U. S. Bureau of Mines Tech. Paper 158.

Natural gas is odorless, tasteless, colorless, and non-poisonous. When burned with a sufficient amount of air, it forms a transparent, blue flame. Its high heat content and high flame temperature make it an excellent fuel. It needs no preparatory treatment and is easily transported. Natural gas is used chiefly as a fuel for domestic and industrial purposes. When used with the proper appliances, it gives excellent illumination.

Accumulation and relation to structure

As will be noted from the natural gas maps of the quadrangle (plates 7, 8, 9, 10), there is little apparent relationship between the subsurface structure and the occurrence of natural gas, and that the anticlinal theory of accumulation is practically non-operative. Dry holes, or wells with only "shows" of gas were drilled on the anticlines as well as the synclines, and, conversely, productive wells were drilled on the synclines as well as the anticlines. However, the larger proportion of failures appear to occur in the lower parts of plunging synclinal axes. This is particularly notable in the Punxsutawney syncline south of Valier, Fordham, and Sportsburg.

One of the factors in the accumulation of gas in this area is the lenticular character of the sand bodies. A diagrammatic conception of the nature of the sands is shown on plate 11. This illustration was constructed from records of wells in a general north-south direction from southwestern Oliver, across western Perry, North Mahoning and East Mahoning townships. The wells do not fall in a straight line as it was necessary to diverge a little from it to include wells for which more complete records were had. The township well number and quarter section of natural gas map is indicated above each section. The datum is the top of the Catskill red beds. Structure could not be shown because elevations were lacking for some of the wells.

From that diagram, it is evident that the sands generally are not continuous units of uniform thickness, but rather are lenticular beds, thickening and splitting into two or more parts locally. Sands that are surrounded by impervious shales form almost ideal reservoirs for accumulation of gas and are essentially what is called the stratigraphic trap type of accumulation. This type of accumulation is common throughout the oil and gas-producing areas of western Pennsylvania. The lenticularity of the sands may be accounted for either by an actual dying out of the sand or by transition into shale.

Theoretically, when a gas-bearing sand lenses out on the flank of a structure, it would be expected that the gas would be localized at the upper limit of the sand. The structural theory, therefore, is operative only insofar as the reservoir rock permits it to function and the result is that gas may occur in these sands in almost any structural position. It is obvious, therefore, that accumulation in a gas-bearing sand would occur in the upper effective limits on the flanks and the rising axis of a syncline and not in the lower parts of a plunging synclinal axis, which, in part, would explain the higher percentage of dry wells at some places in the quadrangle.

Porosity

Porosity is the percentage of voids in a sandstone available for occupancy by either liquids or gases. It determines the storage capacity and the potential production, provided the voids are filled with gas. There are two types of porosity—total and effective. Total porosity includes all the voids in a sandstone, whereas effective porosity includes only those voids that are connected with one another.

In the Smicksburg quadrangle, gas is not always encountered at the top of a productive sand, but usually occurs at some depth in

the sand; and a given sand may contain two or more "pays" in the same well. Furthermore, a body of sand may have a wide areal extent, yet yield gas from relatively small areas, and, also may be dry on normally favorable structures. Therefore, assuming that other prerequisite factors for accumulation were operative, the porosity of the sands apparently varies in areal extent and in section, which largely accounts for the spotty production from the various sands. It, also, probably accounts for the occurrence of gas at some places on the plunging axes of synclines.

Drillers "sands"

The oil and gas sands were named in the localities where they were important producers. Although many other names have been applied locally, the original names have been carried from one field to another by operators and drillers. In the earlier work of the Pennsylvania Geological Survey, the sands have been traced in a general way by their relationship to identifiable horizons, such as coal beds, Vanport limestone, and top of Catskill red beds. In recent years, the Geological Survey has correlated the sands in some fields, but this work has not yet been carried progressively into the area covered by this report. Sisler[62] correlated the oil and gas sands of western Pennsylvania and gave composite sections for counties and townships. This work is too general to have traced the sands as definite stratigraphic units. The progressive thickening of the strata, from west to east, is accompanied by more sands in this area. Partly for that reason, but mainly because the drillers have their own peculiar ideas for naming the sands, there is considerable confusion in the names of the sands on the drillers' logs. The names most used, however, generally conform to the sequence and to the approximate positions of the sands where the names originally were applied. As a basis for discussion of the gas sands in the Smicksburg quadrangle, a composite section was compiled from Sisler's sections for the townships that lie within and partly within the quadrangle, modified by the driller's interpretations.

Without benefit of sections constructed from complete sets of samples from distributed wells, and descriptive sand characteristics indicated on reasonably accurate drillers' logs, correlation of a multiplicity of sandstones from well to well is exceedingly difficult. As was previously discussed, the drillers' logs of wells in this area are usually incomplete and doubtfully accurate; therefore, correlation of the sands in this report is to be considered very tentative.

Some 1,000 skeleton-type records of wells drilled in the quadrangle were collected. Records showing recognizable horizons, or in which key horizons were otherwise determined, were plotted on well-log strips on a scale of one-inch equals 100 feet. Each plotted section was checked with the composite section mentioned above and the probable identity of the sands was determined accordingly.

Of the plotted records, more than 200 were selected as being more nearly complete and representative of the sands in the townships.

[62] Sisler, J. P., and others, Contributions to Oil and Gas Geology of Western Pennsylvania: Penna. Geol. Survey Bull. M19, 1933.

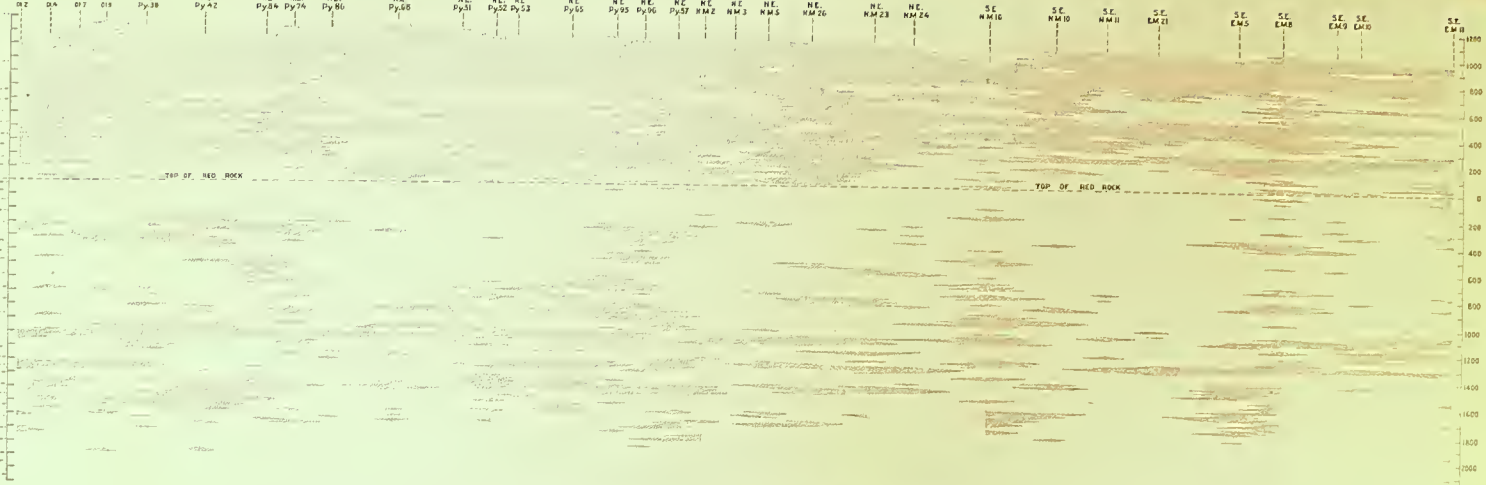


PLATE 11. DIAGRAM SHOWING THE LENTICULAR CHARACTER OF THE GAS SANDS.

They are presented graphically on figures 88-95, and are aligned on the apparent top of the Catskill red beds. At the top of each log is shown the well number, township, and quarter section of the natural gas map. Lines have been drawn connecting probable sand equivalents, and the names of the sands have been placed where convenient.

These sections give a fair idea of the nature of the gas sands. As pointed out previously, the sands are essentially a series of irregular lenses; some are thick, others are thin. All vary in thickness and split into two or more parts locally. Some abnormally thick beds probably contain partings that the drillers either missed or failed to record. A few sands appear to be rather persistent, occur at fairly regular positions in the section, and because of questionable accuracy of the drillers' logs which permit some elasticity, can be traced over relatively large areas with some degree of certainty. There are 30-odd named sands within an interval of about 3,200 feet. Many of these sands produce more or less gas locally.

Description of Drillers "Sands"

Big Injun sand. The Big Injun or Mountain sand was named in Washington County. In the Smicksburg quadrangle, the top of this sand as logged by the drillers occurs at an average depth of 460 feet below the top of the Upper Freeport coal, and ranges considerably above and below that depth. The normal thickness is about 280 feet. Some records indicate an unbroken bed of sandstone up to 500 feet thick, but these abnormal thicknesses include lower sands and the Pottsville sandstones above. The thickness also is reduced to 40 feet locally, and a few records show the sand missing. One or more shale partings are common; they range in thickness from a few feet up to a little over 100 feet. The Big Injun sand commonly is water-bearing, with fresh water usually occuring in the upper part and salt water in the lower part.

Gas in commercial quantities is rare in the Big Injun sand. Small quantities or "show" gas were reported to occur in this sand in wells in northern North Mahoning township, north and northeast of Trade City (29, 43), and north of Marchand (61); in South Mahoning Township north of Plumville (20), and south of Plumville (26, 28, 29); and in Cowanshannock Township south of Sagamore (30).

Squaw, First Gas, Second Gas and Berea sands. Below the base of the Big Injun, there is an interval of about 330 feet that is generally occupied by a succession of exceedingly irregular sandstones interbedded in shales, and includes the Patton red beds. In this interval drillers log in descending order: the Squaw, First Gas, Second Gas, and Berea sands. These sands vary in stratigraphic position, in thickness, and locally are split into two or more parts. Where excessively thick, they may coalesce with the sand immediately above or below. A few records show a continuous bed of sandstone for the entire interval, whereas in a few others the interval is occupied presumably by shale. These variations commonly occur within relatively

short distances, hence the correlation of these sands from well to well is frequently indefinite. The indicated colors are usually white or gray, and occasionally red.

The top of the Squaw sand is at an average depth of 800 feet below the Upper Freeport coal. The normal thickness is approximately 50 feet. Salt water is not uncommon in this sand, but gas is nearly always lacking. A little gas was found in the Squaw sand north of North Point (34), south of Smicksburg (20), northwest of Covode (57), southeast of Georgeville (39), north of Plumville (22), and south of Plumville (28).

The top of the First Gas sand occurs usually 870 feet below the Upper Freeport coal, and the normal thickness of the sand is 45 feet. It frequently contains salt water and has little importance as a gas producer. Only "show" gas was encountered in this sand in Perry Township, north of Frostburg (168); in West Mahoning Township, south of Smicksburg (24); in South Mahoning Township about Plumville (22, 26), and in Washington Township east of Sagamore (15).

The Second Gas sand occurs at an average depth of 960 feet below the Upper Freeport coal. The normal thickness appears to be about 50 feet. The sand may contain salt water, and scattered wells in the quadrangle have encountered gas, but the quantity is not large. Gas was reported in this sand in Redbank Township south of Mt. Tabor (7), south of New Salem (10), north (16) and south of McGregor (19, 21), and at Milton (23); in Ringgold Township north (8) and northeast of Timblin (21); in Porter Township south of Dora (13), and northeast of Porter (33, 35); and in Young Township northeast of Frostburg (1, 6).

Some gas was found in the Second Gas in Perry Township about Frostburg (162, 141, 121, 134), and near Hamilton (28, 20, 25, 57, 58); in North Mahoning Township south of Hamilton (3, 5, 19), about Trade City (13, 14, 11, 26, 27, 42) and north (62, 67) and west of Marchand (15, 152, 29); in East Mahoning Township east (42, 62, 68, 118) and south of Georgeville (17, 10), northeast (135), northwest (32) and south of Marion Center (49); in West Mahoning Township south of Smicksburg (26); in South Mahoning Township near Plumville (30, 7, 27); and in Washington Township south of Sagamore (3).

The sand usually designated by the drillers as Berea, occurs about 1,040 feet below the Upper Freeport coal. The normal thickness is about 55 feet. Salt water is occasionally present. Although this sand is not an important producer of gas, fair production was reported at a few places. A well in Ringgold Township west of Ringgold (15) is producing from the Berea; some gas was encountered in it in Porter Township northeast of Porter (48), and in West Mahoning Township south of North Point (18). In Perry Township the Berea was found to contain some gas in the vicinity of Grange (42, 79, 5, 73, 49, 85, 110), Frostburg (149, 153, 154, 190, 193, 194, 157) and Hamilton (90, 93, 59, 58); and in Young Township northeast of Frostburg (1a, 4, 5).

The Berea sand contains some gas in North Mahoning Township near Trade City (26, 27) and northwest of Covode (47, 52). As determined from 7 wells west and southwest of Marchand (32, 34, 39, 48, 54, 49, 50), the Berea produces some gas from a relatively large and irregularly shaped pool. A little gas was reported from the same sand farther west (20) and northeast of Marchand (67, 76). Three wells in northwestern East Mahoning Township (38, 18, 2) and one in southwestern North Mahoning Township (2a) produce some gas from the Berea sand in what appears to be a narrow and slightly sinuous pool. Scattered wells east and southeast of Georgeville (63, 65, 68, 70, 113, 57) and northeast and southeast of Marion Center (100, 81) encountered gas in this sand. Gas was reported from the Berea in South Mahoning Township in the vicinity of Plumville (36, 59, 24) and in Cowanshannock Township north of Sagamore (2, 7).

Murrysville sand. The Murrysville sand was named after the hamlet in Westmoreland County where, in 1878, it was discovered to be a prolific source of natural gas. The sand commonly logged as Murrysville in the Smicksburg quadrangle lies about 1,110 feet below the Upper Freeport coal. Its top is distinguishable on most of the well records. The thickness of this sand ranges from about 10 feet up to a little over 100 feet, but the normal thickness is from 60 to 80 feet. On some records, sand is not logged at the position of the Murrysville, and on others it is shown joined with either the Berea above or the Hundred-foot below or both. In some areas the Murrysville appears to maintain a fairly uniform thickness and occurs at a rather regular position in the section, whereas in some other areas the sand is very erratic, may also be split into two or more parts, and the partings do not occur at regular positions. This sand is usually described as gray or dark and occasionally red. Probably because nearly all of the wells have penetrated the Murrysville, it is productive over relatively large areas. Large volumes of gas have been encountered in this sand locally, some wells having produced several million cubic feet of gas per day. It was reported, however, that most of the big producers with higher rock pressures "blow down" and become exhausted within a relatively short time. Many wells that become exhausted in the Murrysville have been deepened, and gas has frequently been found in a lower sand. Gas is usually encountered 10 to 30 feet in from the top, but "pay" horizons may occur anywhere in the sand.

The Murrysville sand is more productive in the eastern part of the Smicksburg quadrangle where gas has accumulated in some relatively large pools. A small pool occurs in southwestern Oliver Township (1, 5, 7, 9, 10); another southeast from there lies partly in Oliver (17, 18) and Perry (81, 80, 89, 40) Townships, and two wells in southeastern Porter Township (20, 22) produce from this sand. In Perry Township, the Murrysville contains gas in a small pool north of Grange (44, 45, 75, 84, 83, 110, 113) and in wells west (35, 4, 6, 30, 31), south (68), and east (109, 111, 139, 119) of Grange. A large, irregular gas pool in the Murrysville begins in western Young Township (8, 9, 11, 12, 13); extends westward into Perry

Township around Frostburg (118, 164, 172, 178); thence, southward (186, 184, 135, 156) to east of Hamilton (131, 132, 133, 104, 123, 124, 125, 126), where the pool widens locally, and then turns westward (100, 95) through Hamilton (94, 92, 66, 63, 62), to southwestern Perry Township, where it terminates in a north-south projection (55, 14, 15, 13, 16, 18, 19, 21, 23).

Gas from the Murrysville is reported in wells in northwestern North Mahoning Township (31, 20, 2, 4, 5, 6, 15, 8, 10, 28, 29) and small pools occur south (38, 45, 37, 26, 25, 27, 28, 23, 20) and southwest (1, 5, 8) of Trade City. A gas pool in the Murrysville begins northwest of Covode, trends irregularly southward (57, 54, 48, 43, 49, 50) to Covode (61, 59, 70, 71, 62), then continues southward (64, 65, 63, 57, 61, 58, 53, 49, 50, 42) becoming wider (33, 30, 22, 21, 14, 11, 13, 31), and extends into East Mahoning Township (64, 66, 90, 67, 89, 91, 69).

In East Mahoning Township, the Murrysville produces some gas from a small pool west and south of Georgeville (9, 3, 22, 6, 7, 17, 16), and from small pools north (46, 52, 76, 77), south (78, 83, 79, 82, 103, 102, 101) and east (131, 128, 132) of Marion Center. A few scattered wells elsewhere in the township (39, 15, 96, 136, 124, 99, 14) produce gas from this sand. The Murrysville sand produces gas locally in northwestern Rayne (18, 19) and northern Washington (16, 15, 14, 2, 3, 4, 5) Townships; and in Cowanshannock Township, north (10, 13, 14, 15, 17) and south (25, 27, 28) of Sagamore. Some production occurs in this sand in South Mahoning Township around Plumville (26, 29, 31, 15, 34) and north of Denton (1), and in a small pool near Rossmoyne (54, 47, 49, 52, 51).

The Murrysville sand produces gas from a narrow pool that begins in southeastern West Mahoning Township (2, 4, 5, 6, 7, 8, 10, 1) and extends to east of Smicksburg (40, 41, 43). Smaller pools occur just east (32, 33, 31, 29) and north (22, 26, 27, 15, 13, 14) of Smicksburg, and some gas was encountered in wells southeast (14, 37), south (20, 19) and west (1, 2, 3) of Smicksburg. A well north of North Point (34) and another north of Loop produce from this sand.

A narrow, irregular pool in the Murrysville lies partly in West Mahoning (1, 7, 8), Wayne (10, 8, 5), Redbank (24), and Porter (1, 2, 4, 5, 6, 7, 18) Townships. Good production was reported from wells in Wayne (1, 2, 4) and Redbank (17, 15, 13, 7, 1) Townships. Wells in eastern Porter (24, 27, 28, 30, 15, 42, 40, 43, 46, 48) and southern Ringgold (7, 8, 3, 23, 22, 29, 35) Townships also produced some gas from the Murrysville.

Hundred-foot sand. In the Smicksburg quadgrangle, the name Hundred-foot is generally applied to a sand or group of sands occurring within an average interval from 1,200 to 1,295 feet below the Upper Freeport coal. The thickness of the Hundred-foot sand or sands varies considerably and, where abnormally developed, the drillers frequently include the Murrysville and Thirty-foot. Most of the gas in the Hundred-foot was found in the northern part of the quadrangle and apparently is confined to relatively small pools.

Although some large gas wells have been "drilled in," it usually produces only small quantities of gas. Most of the gas occurs within a few feet from the top of the sand, but other "pay" horizons in the sand are not unusual.

Two wells in Redbank Township north of New Salem produced gas from the Hundred-foot (3, 6); and good production was reported to have been found in some of the wells in Ringgold Township (1, 3, 20, 26, 28, 35). A small pool in the Hundred-foot occurs in northeastern Porter Township (14, 44, 40, 38, 41), and another small pool lies partly in southwestern Porter (2, 3, 6, 19) and northwestern West Mahoning Townships (3, 4). Gas in the Hundred-foot was encountered in southeastern Porter Township (24, 27) and in West Mahoning Township southeast of Loop (16), west (3), east (33) and south (16, 24) of Smicksburg. Small quantities of gas come from the Hundred-foot in southwestern Oliver Township (7, 13, 15). It is productive in Perry Township in the vicinity of Grange (39, 79, 81, 114, 73, 31, 29, 50, 107, 117), Frostburg (167, 166, 165, 188, 187, 189, 192, 180, 137, 134) and Hamilton (128, 95, 96, 93, 61, 21) and also contains some gas in Young Township (7, 8, 13). The Hundred-foot sand generally is nonproductive elsewhere in the quadrangle although gas was encountered in it north of Trade City (1, 14) and northwest of Covode (51); east of Georgeville (51, 117) and northeast of Marion Center (109); near Rossmoyne (53), northwest of Plumville (15, 22) and west of Denton (2). A well in northeastern Washington Township (15) also found some gas in the Hundred-foot sand.

Thirty-foot sand. The Thirty-foot occurs immediately below the Hundred-foot and is frequently logged as a continuation of it. Where the Thirty-foot is identifiable as a distinct unit, the top lies at an average depth of 1,310 feet below the Upper Freeport coal. The thickness normally ranges from 10 to 50 feet. It sometimes is logged as a white sand and occasionally is pebbly. The Thirty-foot contains gas locally and good production was reported to have been found at a few places.

Gas from the Thirty-foot sand was found in Redbank Township northeast (2, 5) and south (10, 13) of New Salem. In Ringgold Township, Thirty-foot production comes from a relatively long and narrow pool lying north and northeast of Timblin (13, 3, 10, 5, 9, 19, 24) and from two wells near Ringgold (28, 31). Some gas was reported in this sand in northeastern Porter Township (15, 41); and a well in northeastern Wayne Township (10) produces from it. Gas from the Thirty-foot was encountered in northern West Mahoning Township east of Milton (1, 2, 7) and south of Loop (13); and in the southern part of this township east (31) and south (21) of Smicksburg. A well in Oliver (26) and one in Young (11) Townships found some gas in this sand.

Most of the gas in the Thirty-foot sand was discovered in Perry Township and it comes from scattered wells around Frostburg (167, 147, 162, 164, 151, 138, 136), Grange (69, 87, 107, 118, 33, 36, 3, 33, 8), and Hamilton (14, 59, 132). A little production was reported

north of Trade City (19, 22), east (41) and southeast (34, 35, 59) of Georgeville, northeast of Marion Center (99, 96, 123, 122, 136); and in eastern South Mahoning (23, 19, 14, 15) Township.

Boulder and Snee sands. Farther west in Pennsylvania the names Boulder and Snee are applied to a sand that occurs in the interval between the bottom of the Thirty-foot sand and the top of the Catskill red beds. At some places in this area, two sands are present in that interval and the name Boulder is used to designate the first sand below the Thirty-foot, and Snee is applied to the sand immediately above the Catskill red beds.

The sand called Boulder is very erratic in occurrence. On many well records, it is logged with the Thirty-foot or Snee, or both. Where present as a separate unit, the top averages 1,390 feet below the Upper Freeport coal, or 90 feet above the top of the Catskill red beds; and the thickness averages 35 feet. The Boulder is unimportant as a producer of gas. Some gas was reported in this sand in Perry Township near Grange (74, 85) and Frostburg (152, 182); in North Mahoning Township northwest of Trade City (13); and in South Mahoning Township southwest of Georgeville (16) and northeast of Plumville (31).

The Snee sand is generally nonpersistent and, where developed, it lies on or a little above the top of the Catskill red beds. Its average thickness is 30 feet. Gas occurs rarely in this sand. Wells in northwestern Washington (1, 2), southeastern North Mahoning (73), southeastern Perry (128) and southwestern Oliver produced some gas from the Snee sand.

Sands in the Catskill red beds. At least four sands occur in the Catskill red beds in the Smicksburg quadrangle. They are, in descending order, Gordon Stray, Gordon, Bayard, and Bayard Stray. These sands are only local developments, all of them rarely being present in the same well section. Their respective average positions below the top of the red rock are 40, 80, 180, and 270 feet. On some well records a sand is shown in the interval between the Gordon and Bayard, and on some other records a sand is logged between the Bayard and Bayard Stray. These sands commonly are called Fourth and Fifth sands, respectively. The sands in the Catskill red beds seldom exceed a thickness of 30 feet, and are variously described as dark, gray, white, and red. They are not known to contain commercial quantities of gas. Only "show" gas is reported on the well records.

Elizabeth and Elizabeth Stray sands. The sand generally named Elizabeth occurs at or a little below the base of the Catskill red beds. It is fairly persistent and has a rather uniform thickness of about 35 feet. However, its thickness is greater locally and in such cases the Elizabeth may merge with the Bayard Stray (if present) or the Elizabeth Stray. The only known gas production from the Elizabeth is north (92, 86, 57, 55) and northwest of Marion Center in East Mahoning Township.

The Elizabeth Stray is an erratic sand that lies approximately 50 feet below the base of the Elizabeth or at an average depth of 410 feet below the top of the Catskill red beds. Its average thickness is 30 feet. So far as is known, this sand is barren of gas throughout the quadrangle, although a well in Perry Township west of Grange reportedly is producing from it.

Warren sands. The First, Second, Third, Fourth, and Fifth Warren sands occupy respective average positions of 460, 540, 610, 690, and 770 feet below the top of the Catskill red beds; and their respective normal thicknesses are: 30, 35, 35, 40, and 35 feet. The first four of this series of sands are rather local in occurrence, and nearly always are dry. The Fifth Warren, however, is fairly persistent and is an important producer of gas at some places. The drillers frequently name this sand the Speechley or Clarendon, and usually describe it as being chocolate or red and occasionally pebbly.

The Fifth Warren produces gas from three small pools in Perry Township, west (13, 14, 15) (17, 19, 21) and northwest (27, 28, 50, 51) of Hamilton; also, from a well southeast of Grange (87). Gas was reported in this sand in a well in southwestern Oliver Township (10). A narrow and irregular gas pool in the Fifth Warren sand occurs in West Mahoning Township south of North Point (15, 26, 27, 28, 31, 32). Gas in this sand also was encountered in wells south (10, 16) and east of Smicksburg (41). Some gas was produced from the Fifth Warren in East Mahoning Township north (95), northwest (27), and east (127, 130, 129) of Marion Center; also, in Cowanshannock Township north (3) and northwest (19) of Sagamore.

Speechley Stray sands. Lenticular sands occur in the first 200 feet below the Fifth Warren sand. Although nonpersistent, two horizons in this interval appear to be more consistently sandy and usually are designated Speechley Stray Stray and Speechley Stray. The former sand is about 880 feet below the top of the Catskill red beds, and its normal thickness is 35 feet. The latter sand is 100 feet lower and its normal thickness is 30 feet. No important gas production is known from these sands. The Speechley Stray produced a little gas from a well in Redbank Township northeast of New Salem (4) and in West Mahoning Township southeast of Smicksburg (37).

Speechley sand. The name Speechley was originally applied to a sand in Venango County. The sand tentatively correlated with the Speechley in the Smicksburg quadrangle occurs at an average depth of 2,560 feet below the Upper Freeport coal, or 1,080 feet below the top of the Catskill red beds. Most of the records of wells drilled in the quadrangle show the Speechley, and it probably is the most persistent sand below the Murrysville-Hundred-foot group. The thickness of this sand ranges from about 10 to a little over 100 feet locally; 50 feet is about normal. The sand maintains a remarkable uniform thickness and position in some areas, particularly in Perry and parts of West and South Mahoning Townships.

The Speechley is a prolific producer of gas in some areas of western Pennsylvania, but not in this quadrangle. In North Mahoning Township, the Speechley produces from a small pool lying generally east of Covode (64, 65, 70, 74, 75); and from wells northwest (15) and west (25) of Trade City, and north of Georgeville (12, 16). A few wells encountered gas in this sand in East Mahoning Township south (5) and east (118, 121) of Georgeville and northeast (109) and south (80) of Marion Center. Some production also was found in the Speechley in northern Washington Township (11); in South Mahoning Township east (29) and south (27, 28) of Plumville; in eastern Ringgold (35a), northern Porter (47), northern West Mahoning (17) and southwestern Oliver (5) Townships. A show of oil was reported in the Speechley in northwestern Perry Township (32).

Tiona sand. Several sands occur below the Speechley. As they are exceedingly irregular in character, their identity from well to well is very problematical. A sand occupying an average position of 1,220 feet below the top of the Catskill red beds is called the Tiona. Its normal thickness appears to be about 30 feet. Where the sand is abnormally thick, it merges with the sand below or above. Commercial quantities of gas have been found in this sand locally, particularly in the eastern part of the quadrangle. Production is from a narrow, winding pool lying generally north and northwest of Frostburg (142, 150, 152, 154, 161, 171, 178) in Perry Township. Other wells producing from the Tiona in this township are situated southeast (187) and south (182, 134) of Frostburg, northwest (38), east (85a), and southeast (118) of Grange, and northeast (104) and south (59) of Hamilton. In North Mahoning Township, the Tiona produces from a crescent-shaped pool around Covode (71, 59, 61); two wells west of Trade City (7, 12) encountered some gas in this sand; and a fairly large pool in the Tiona begins west of Trade City (28, 25, 24, 9) and extends southwest (1) into West Mahoning Township (11, 9, 8, 6, 5, 2, 3). Wells in East Mahoning Township southeast of Georgeville (72, 87, 114), north (51), east (128), and southeast (104, 106) of Marion Center; and in South Mahoning Township southeast (62), northwest (21) of Plumville, and northwest of Denton (2); also, in Cowanshannock Township north of Sagamore (8, 9), produce from the Tiona sand.

Balltown sands. The First Balltown sand is about 1,290 feet below the top of the Catskill red beds. Although it may be absent or abnormally thick at many places, it normally ranges little from 35 feet thick. Scattered production was reported from this sand in Perry Township, southwest (120, 136) and south (185) of Frostburg; east (117) and southwest (46, 31, 9, 29) of Grange, and west (19), north (91), and east (100) of Hamilton; in North Mahoning Township, north (21, 13) and south (4, 8, 19, 23, 13) of Trade City and north of Covode (68); also, in southeastern West Mahoning Township (4, 5, 6, 12); in East Mahoning Township south (16) and west (89, 94) of Georgeville, and in South Mahoning Township north of Denton (1).

The Second Balltown sand is at an average depth of 1,350 feet below the top of the Catskill red beds, and its normal thickness also is about 35 feet. Good production is reported to have been found in this sand, and gas has accumulated in a few relatively large pools. Three wells in Young Township obtain some gas (5, 9, 11) from this sand. In Perry Township the Second Balltown contains gas in a narrow, winding pool that extends from southwest of Frostburg (135, 138, 119, 118, 88, 86) to southwest of Grange (72, 33, 48, 32, 30); a well northwest of Frostburg (165) and two north of Grange (45, 84) also found some gas in this sand. The Second Balltown is productive from a small pool northwest of Hamilton (62, 63, 64, 65, 66), and from wells northeast (123, 132) and south (57) of that place. Gas is produced from this sand in North Mahoning Township in wells north (31) and west (12, 10) of Trade City; also, from a pool south of Trade City (5, 4, 16, 15, 14, 28, 29). Some production comes from the Second Balltown in East Mahoning Township, south (22, 23, 10), east (65, 93, 115, 121) and southeast (94, 86, 57) of Georgeville, and north (51, 52), east (107), and south (48) of Marion Center. Scattered production was found in this sand in South Mahoning Township southwest of Georgeville (19, 14), near Rossmoyne (48, 49), and northwest (11, 12) and south (26) of Plumville. Gas comes from a pool in the Second Balltown in Cowanshannock Township north of Sagamore (19, 17, 12, 10, 8, 5). Another pool extends from east of Smicksburg (40, 41, 42) in West Mahoning Township to the eastern township boundary (1, 10, 12).

Sheffield sand. The Sheffield is a very erratic sand below Second Balltown, or at an average depth of 1,410 feet below the top of the Catskill red beds; it normally has a thickness of about 30 feet. This sand has negligible importance as a producer of gas, but some production was obtained from it in Perry Township southwest (180) and southeast (187) of Frostburg; west (3) and north (76) of Grange; and west of Hamilton (61); in North Mahoning Township north and northeast of Trade City (21, 42) and south of Marchand (51); East Mahoning Township, north (123), northeast (133), and southeast (81) of Marion Center; Cowanshannock Township, north of Sagamore (16); West Mahoning Township, east of Smicksburg (29); and in southeastern Wayne Township (1).

Bradford sands. Immediately below the normal position of the Sheffield sand comes an interval of approximately 230 feet of interbedded shale and sandstone in which more regularly occur three sands at average depths of 1,490, 1,560 and 1,630 feet below the top of the Catskill red beds. All range in thickness from a normal of 40 feet. These sands in their respective order have been designated First, Second, and Third Bradford. Important gas production has come from these sands in various parts of the Smicksburg quadrangle.

The First Bradford sand is gas-bearing in wells in Perry Township northwest (165) and southwest (120) of Frostburg; north (76), south (27) and southeast (109) of Grange; and in a well in Young Township northeast of Frostburg (2). It also is gas-bearing in North

Mahoning Township northwest (56), west (39) southwest (32), and east (76) of Marchand; and in East Mahoning Township south (5) and southeast (59) of Georgeville, and northwest (46), southeast (103), and east (127) of Marion Center. Wells in southeastern South Mahoning (61, 62), northwestern Washington (7, 10) and Cowanshannoek (24) Townships produeed some gas from the First Bradford.

The Seeond Bradford sand generally is non-productive. The only known occurrence of gas in this sand here is in southeastern Oliver (21) and northwestern Perry (76) Townships; in North Mahoning Township south of Trade City (19, 15a, 11) and southwest of Marchand, and in southeastern Wayne (2) and in Redbank (1, 18) Townships.

Produetion from the Third Bradford sand was encountered in wells in Perry Township near Frostburg (167, 181), Grange (43, 4, 68) and Hamilton (126); in North Mahoning Township near Marchand (56, 37, 77, 30); East Mahoning Township near Marion Center (125, 80); southwestern South Mahoning Township (24) and in northern Washington Township (11). Gas also was eneountered in this sand in Cowanshannoek Township north (10, 14a, 17) and south (27) of Sagamore; West Mahoning Township northwest of Trade City (4), east (28) and south (11) of Smicksburg, south of North Point (31, 28, 22), and southeast of Milton (1); in northeastern Porter Township (42, 47), and in Redbank Township (3, 14).

Kane sands. The First, Seeond, and Third Kane sands occupy average positions of 1,710, 1,820 and 1,900 feet, respectively, below the top of the Catskill red beds. They all appear to have a normal thiekness of about 30 feet, but thieken or are missing loeally. Not many of the wells in the quadrangle have penetrated these sands, partieularly the lower ones.

The First Kane sand appears to be rather persistent and maintains a fairly constant position and uniform thiekness. Important quantities of gas have been found in it at some plaees. A well in Young Township (4) and two in southwestern Oliver Township (6, 14) found some gas in the First Kane. In Perry Township it produees from a pool south of Grange (7, 30, 31, 32, 48, 46, 72, 86, 108); and from wells north (42, 84) and northwest (35, 36) of Grange; north (172) and west (141) of Frostburg; and west (62) and south (96) of Hamilton. The First Kane was found produetive in West Mahoning Township in a pool lying east (42, 43, 29, 31) and north (19, 18, 22, 23, 28) of Smicksburg; also in a small pool south of Smicksburg (16, 23) and in a well southeast of Milton (4). Gas was eneountered in this sand in eastern Porter (31, 43, 45) and Cowanshannock (26) Townships; in South Mahoning Township south of Plumville (26, 28) and southwest of Georgeville (22); in North Mahoning Township north (1, 2, 4) and east (37, 39) of Trade City, and in southeastern East Mahoning Township (132, 133).

The Seeond Kane sand produces from a small pool in southwestern Oliver (13, 11) and northwestern Perry (38, 39) Townships;

and from wells in North Mahoning Township south and southeast of Trade City (38, 10) and southwestern West Mahoning Township (2, 5). The Third Kane sand contains some gas in southwestern Oliver (4), southwestern West Mahoning (2), and in Redbank (10) Townships.

Elk sands. Relatively few wells in the quadrangle have pierced the First, Second, and Third Elk sands. The respective tops of these sands occur at average depths of 1,980, 2,060, and 2,180 feet below the top of the Catskill red beds, and their normal range in thickness is from 30 to 40 feet. Sizable gas production from these sands is not known; some "show" gas was reported and a well in southwestern Oliver Township (15) produces some gas from the First Elk sand.

Production

The production of natural gas in the Smicksburg quadrangle is not recorded, but, doubtless, it must have been large. Some idea may be had from the total production in Indiana and Jefferson Counties from 1906 to 1933 which is reported to be 164,000 million cubic feet. Rock pressures and volumes are indicated on only a very few of the well records and most of these include production from two or more sands. The record of a well on the Yarger farm in Redbank Township (14) indicated that gas was encountered in the Murrysville and Thirty-foot sands in July 1905; the initial rock pressure was 410 pounds per square inch, and the initial volume was 1,424,304 cubic feet. When gaged in October 1929, the rock pressure had declined to 50 pounds per square inch and the volume to 14,530 cubic feet. This well was deepened to the Third Bradford sand in 1929 which had an initial rock pressure of 240 pounds per square inch and a volume of 15,169 cubic feet. The well, apparently, was still turned into the line in 1936.

Personal communication with operators and drillers revealed that in this field initial rock pressures ranged up to a little over 900 pounds per square inch, the average range being from about 5 to 500 pounds per square inch. It also was revealed that wells having initial volumes of over one million cubic feet were unusual, and the average range in volumes is from about 50,000 to 500,000 cubic feet. It has been a common practice in this region to gage the lower volume wells by the "height of blaze"—a well having a blaze over 4 feet high is said to be an economic producer. Most of the larger initial volumes of gas come reportedly from the shallower sands such as Murrysville and Hundred-foot, but many of these wells "blow down" or are soon exhausted. The volume of gas in the deeper sands is generally not so spectacular, but the gas lasts longer. This is because rock pressure increases with depth and assuming that porosity and other factors are equal, for any given storage capacity, the higher the pressure, the greater the amount of gas stored and the longer it will take to exhaust that supply.

An estimate of the average productive life of the gas wells in this area is difficult to make. Many of the earlier wells that became exhausted were drilled to deeper productive sands, and the later deep-

ening of a well may or may not be indicated on the record. However, a few wells are known to have produced gas from the same sand or sands for 20 years or more, but it is believed that the average life of the wells is considerably less, probably nearer 10 years. Closely spaced wells drain the gas from a pool sooner than widely spaced wells. Cleaning out declining wells often rejuvenate them so that they continue to produce for a few more years. The life of low-pressure wells may be prolonged by creating a vacuum in the well. A plant for such a purpose is situated west of Timblin, and is operated by the Pittsburgh Plate Glass Company (fig. 86).

Figure 86. Natural gas vacuum plant.

A considerable quantity of the gas produced in the quadrangle is consumed for domestic purposes and in small industrial plants in Punxsutawney and vicinity. The larger quantity is piped to the big industrial centers in the Allegheny Valley, where much of it is used in the manufacture of steel.

The important producers in the quadrangle are: Equitable Gas Co., Manufactures Gas Co., Peoples Natural Gas Co., and T. W. Phillips Gas and Oil Co.

Future Development

The Smicksburg quadrangle, as a whole, has been well explored for natural gas, particularly in the shallow sands and based largely on the known development only a few small, thoroughly untested localities remain. Insofar as could be determined from incomplete well data, the accumulations of gas in the sands do not have definite

trends; they are confined to relatively small areas. The larger pools are narrow and irregular in outline. In many instances, a gas pool has only one well, since the near-by surrounding wells failed to find gas in the same horizon. On the other hand, dry holes have been drilled in the midst of a group of producing wells. Such conditions are due to the lenticular character of the sands and their capability as reservoir rocks and, obviously, are unpredictable. It appears, therefore, that a few widely-spaced dry holes should not finally condemn an area in its entirety. As was discussed previously, the areas on or near the lowest parts of plunging synclinal axes are unfavorable for exploration. Localities where more exploration may possibly find gas are: on the west flank of the Sprankle Mills anticline between Pine Run and Nye Branch; in the vicinity of McGregor, and west of the axis of the Plumville anticline from East Plumville northeast to Little Mahoning Creek.

Some promise of finding more production in the quadrangle is afforded in the deepening of wells that were completed in the shallow sands. Many shallow wells have been drilled to deeper sands with successful results, particularly wells that were productive in the shallow sands and became exhausted.

From available well data, there is some indication of a vertical relationship in the accumulation of gas. Where the shallow sands are productive, the deeper sands more often contain gas; conversely, where the shallow sands are dry, the deeper sands generally are dry. This, however, is only an indication and should not be accepted as a rule.

The Oriskany sand, which was found to be a prolific producer of gas at some places in the plateau regions of northern Pennsylvania, particularly in Potter and Tioga Counties, has not been explored in the Smicksburg quadrangle. F. C. Deemer's W. H. Irwin Company well No. 1, in Gaskill Township, Jefferson County (plate 5) found Oriskany sand 25 feet thick at 7,143 feet below the Brookville coal, but it was dry. The Oriskany sand, if present in this quadrangle, would be expected at approximately 7,480 feet below the Upper Freeport coal. The Lightcap well (plate 5) in East Mahoning Township (30) was stopped about 670 feet above the horizon of the Oriskany. According to Fettke,[63] the Oriskany sand is probably absent in the northwestern part of the quadrangle and probably is present elsewhere in the quadrangle.

As a general rule, there is a definite relationship between the structure and accumulation of gas in the Oriskany.[64] Although the Oriskany is not everywhere present, it is more continuous than the shallow sands and the gas is, therefore, free to accumulate in structural highs or domes.

[63] Fettke, op. cit.
[64] Cathcart, S. H., Pennsylvania Geological Survey Bull. 108.

Figure 87. Skeleton logs of wells drilled for natural gas.

Figure 88. Skeleton logs of wells drilled for natural gas.

Figure 89. Skeleton logs of wells drilled for natural gas.

Figure 90. Skeleton logs of wells drilled for natural gas.

Figure 91. Skeleton logs of wells drilled for natural gas.

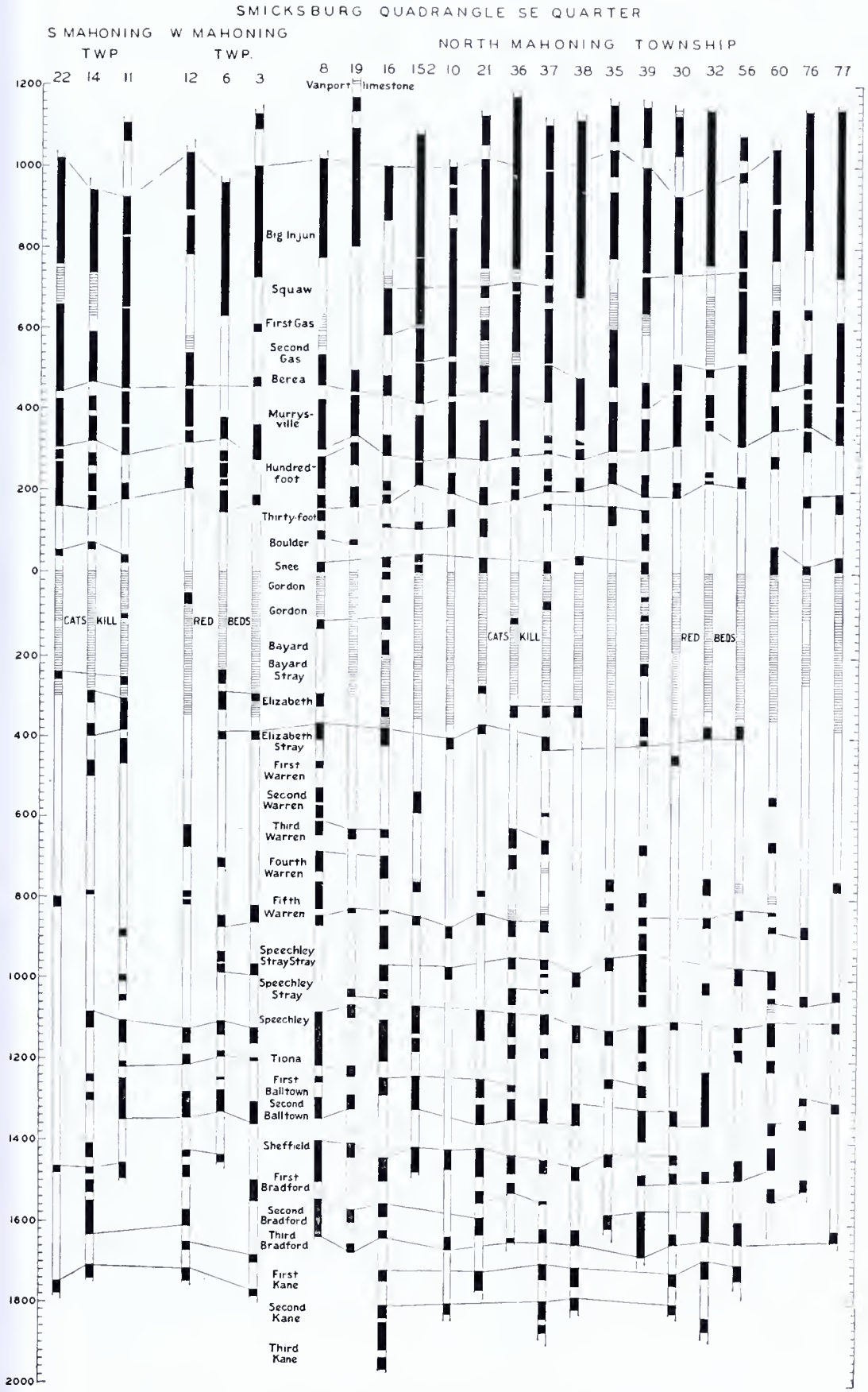


Figure 92. Skeleton logs of wells drilled for natural gas.

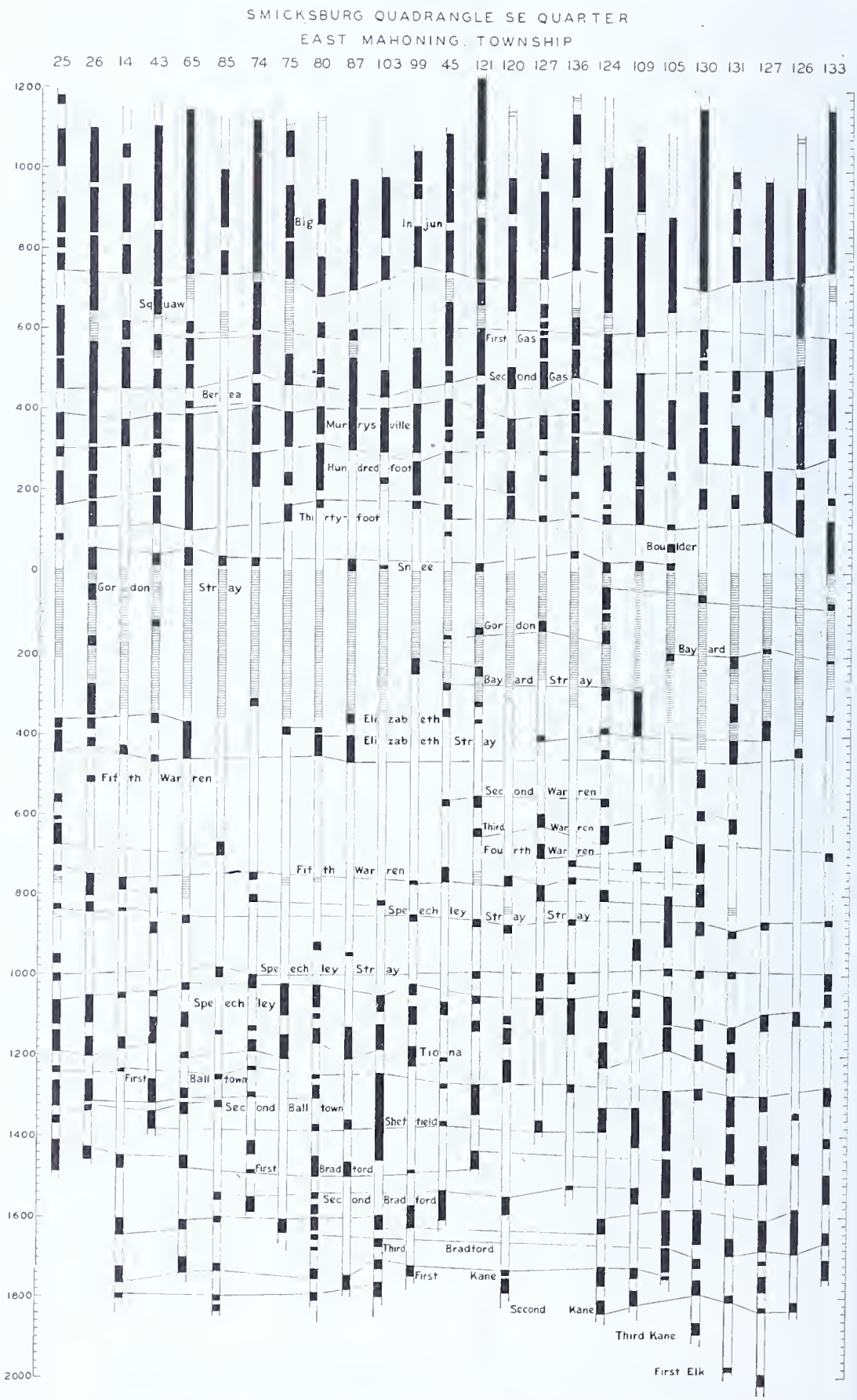


Figure 93. Skeleton logs of wells drilled for natural gas.

Figure 94. Skeleton logs of wells drilled for natural gas.

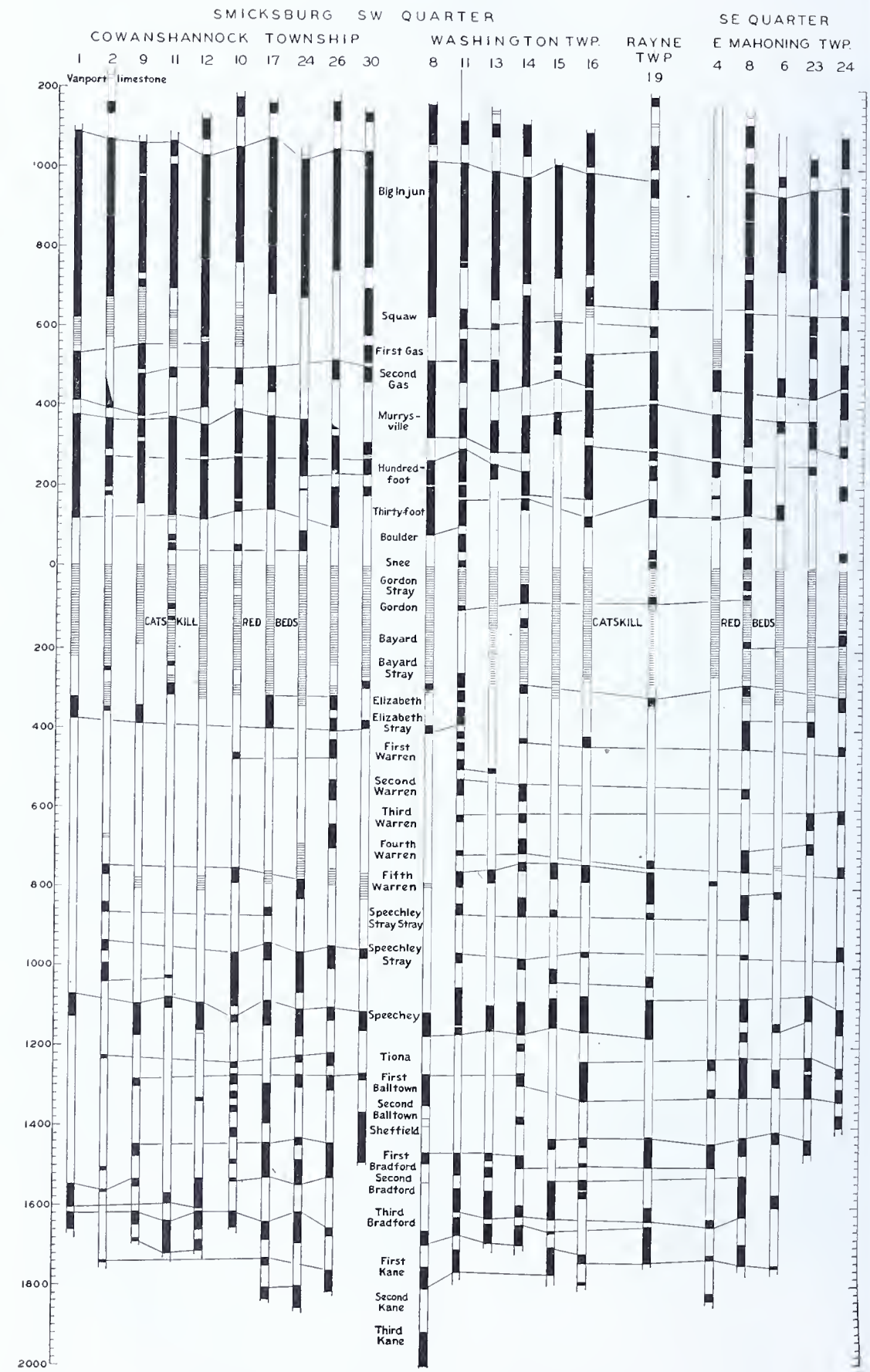


Figure 95. Skeleton logs of wells drilled for natural gas.

CLAY AND SHALE

The clay and shale of the Smicksburg quadrangle consist of underclay that generally occurs under the coal beds and shale that is associated with the strata of the Conemaugh and Allegheny groups. Although there is an abundance of these resources, none of them have been exploited to any extent, nor are they known to have been tested in this area.

Underclays

The underclays are commonly bluish-gray, plastic, and structureless, and have a smooth, soapy feel. They may have smooth polished surfaces called slickensides, which are caused by movements in the clay mass. All underclays are called fireclays by the miners, but since all underclays are not fireclays, that usage has become more restricted to flint clay and beds of refractory underclays. Underclays are essentially hydrous aluminum silicates, and differ from other clays and shales in that they contain a smaller proportion of the oxides of iron, lime, magnesia, soda and potash, which are the fluxing components of the clay. Their presence in increasing amount causes the clay to melt at decreasingly lower temperatures. Refractory clays fuse only at very high temperatures, and this property, together with proper shrinkage and porosity at certain burning temperatures, determines the quality of the clay. It may be classed as the best, or No. 1, or may be rated No. 2 or 3. The lower proportion of fluxing components in underclays is still a controversial question. They seem to have been purified by some leaching process in the coal swamp. They may have been dissolved out by waters containing humic acid, or they may have been removed by roots of plants that grew contemporaneous with the formation of coal.

The underclays are used either by themselves or mixed with other clay and shale. Underclays are used for making brick, tile, and various clay products. They are mixed with shale to make certain quality of brick, tile, or other ware. They must be used with flint clay in the manufacture of refractory ware as the flint clay is non-plastic and will not bond by itself.

The following analyses of plastic underclays from Jefferson County are taken from Report H6 of the Second Pennsylvania Geological Survey and from Clay and Shale Resources of Pennsylvania, Bulletin M23, of this Series by Henry Leighton. They do not include samples obtained from the Smicksburg quadrangle, but are of approximately similar clays and will give some idea of the underclay in this area.

Analyses of plastic underclays from Jefferson County

No.	Ign.	SiO_2	Fe_2O_3	TiO_2	Al_2O_3	CaO	MgO	Na_2O K_2O	MnO	P_2O_5	SO_3
P2	9.72	58.12	3.33	.19	26.50	.07	.55	2.18	—	—	.05
P3	9.09	60.67	2.21	1.61	25.91	.08	.46	1.92	—	—	Tr.
P4	4.16	78.07	1.59	Tr.	14.44	.05	.48	1.67	—	—	Tr.
72	—	59.76	2.64	—	29.30	1.08	1.30	—	—	—	—
256	8.31	62.40	3.39	—	21.10	.97	.21	—	.10	.02	1.45
257	7.66	63.05	4.60	—	19.09	.64	.60	—	.01	—	2.42

Because of the nature of the underclays, they do not crop out clearly. Their presence was noted at numerous places along roads and hillside washings, but rarely was any idea of the thickness or quality obtained. Also, the entire thickness of underclay in the coal

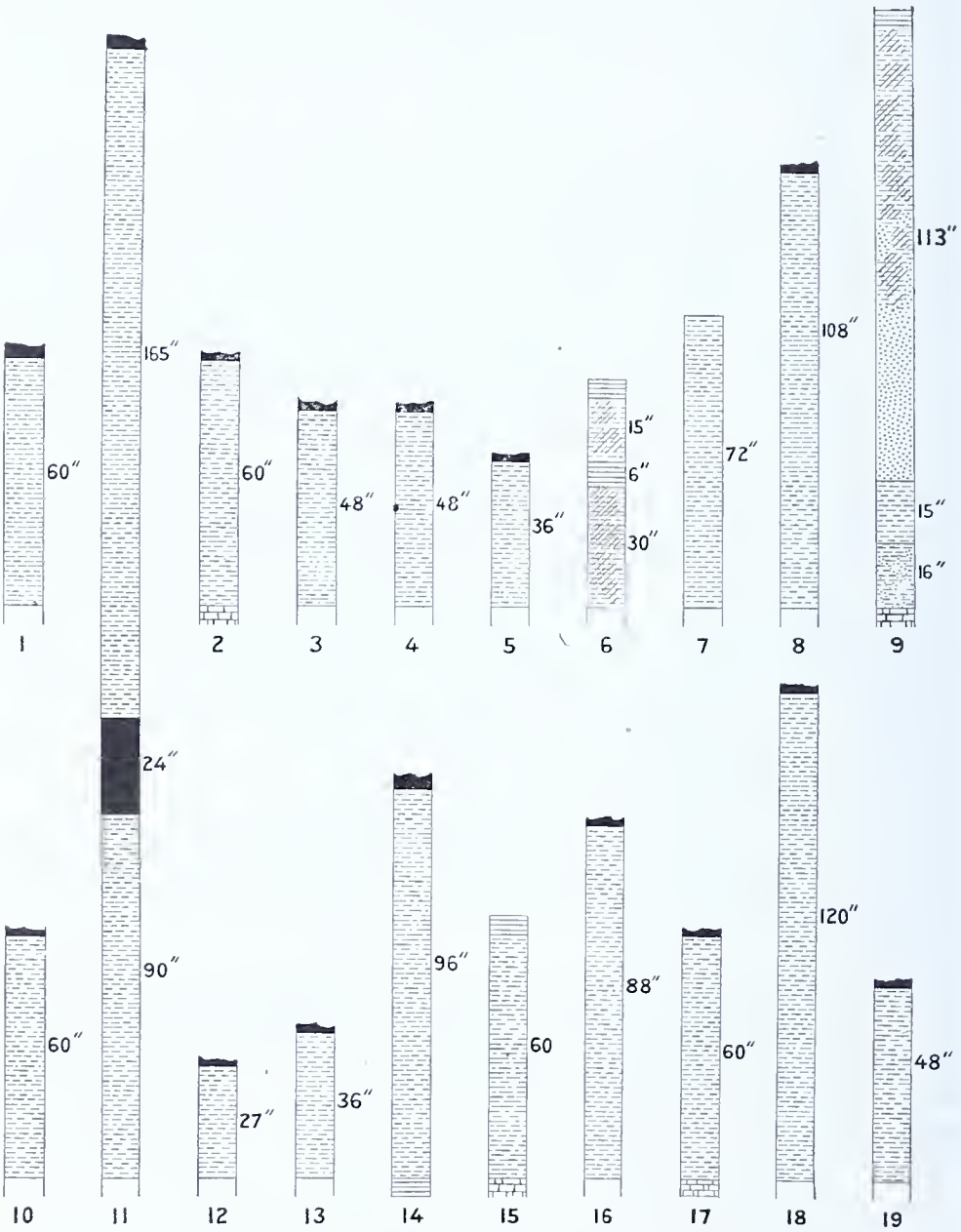


Figure 96. Sections of Upper Freeport underclay.

1. Aa19, country bank. 2. Ba30, country bank. 3. Ba46, Gilbert mine. 4. Ba34, Eagle Valley mine. 5. Diamond drill hole No. 3. 6. Eb29, outcrop. 7. Dc16, outcrop. 8. Cc28, country bank. 9. Ac34, outcrop. 10. Ac39, Summit No. 5 mine. 11. Diamond drill hole No. 83. 12. Diamond drill hole No. 87. 13. Ce3, Rossmoyne mine. 14. Diamond drill hole No. 104. 15. Diamond drill hole No. 102. 16. Diamond drill hole No. 107. 17. Diamond drill hole No. 110. 18. Diamond drill hole No. 121. 19. Fe6, Penn-Troy mine.

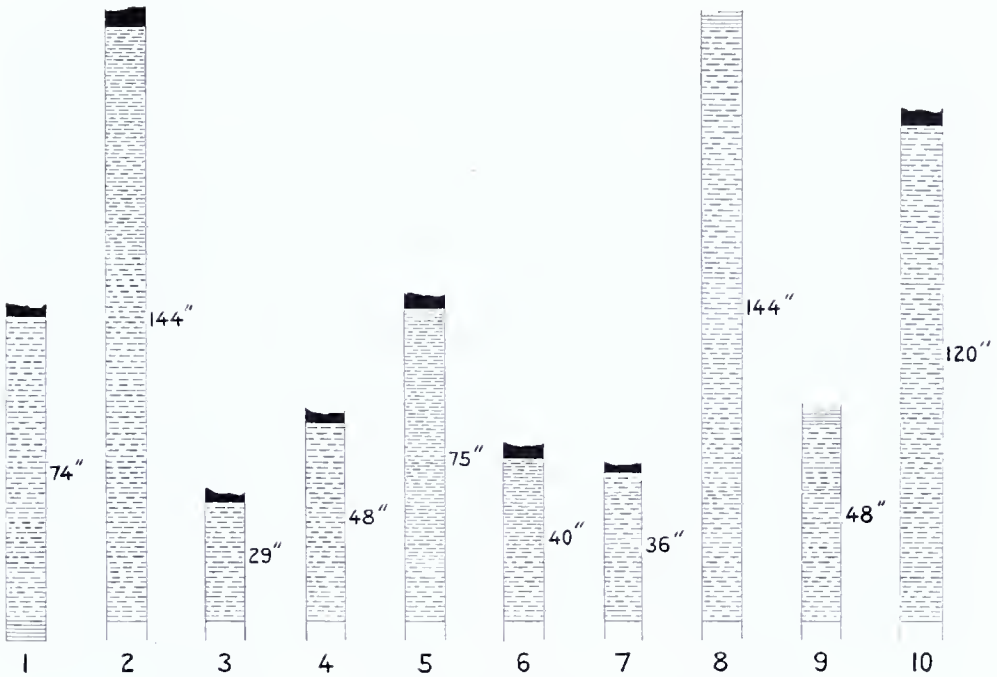


Figure 97. Sections of Lower Freeport underclay.

1. Diamond drill hole No. 1. 2. Aa38, prospect pit on Gruver farm. 3. Diamond drill hole No. 3. 4. Diamond drill hole No. 26. 5. Diamond drill hole No. 5. 6. Diamond drill hole No. 66. 7. Ce7, North Point mine. 8. Diamond drill hole No. 110. 9. Diamond drill hole No. 126. 10. Ef18, Marion mine.

mines is seldom exposed, particularly in country banks. Most of the information was obtained by personal communication with mining engineers and from the logs of diamond core drilling.

From the close association of the underclays with the coal beds, the distribution and outcrop of the underclays may be followed by the outcrop lines of the coal beds as shown on the mineral resources map. Selected sections of underclays in the Smicksburg quadrangle are shown graphically in figures 96, 97, 98.

There are vast reserves of plastic underclay in the Smicksburg quadrangle and doubtless much of it is of excellent quality, but it has not been developed commercially. The only instance of clay having been worked in this area was reported by Platt[65] who states that potters clay underlies the Lower Freeport coal at Frostburg and was once mined to supply a small pottery at that place. Plastic clay is usually present under practically all of the coal beds, but the better quality and uniformly thicker clays are associated with the important coals, namely, the Upper Freeport, Lower Freeport, and Lower Kittanning. Some of those underclays locally exceed 10 feet in thickness, but the normal range is from 3 to 6 feet. The quality also is variable and they tend to become sandy toward the bottom. Some beds locally are worthless mixtures of sand and clay.

[65] Platt, W. G., H6, p. 16.

Flint clay

Flint clay is a name applied to a hard, blocky, non-plastic clay that breaks with a smooth concoidal fracture and sharp edges similar to fine-grained limestone. It commonly has a light or medium-gray color but may be bluish. It occurs as an underclay, either as a definite bed or as part of a bed of plastic clay, and often occurs as a lense in plastic clay. Unlike other clays, it does not weather to a mud but retains its flint-like character until reduced to powder. It may be too siliceous or too ferruginous to be of value, but usually it is purer and more refractory than the plastic variety. Flint clay being non-plastic must be mixed with a plastic clay for a bond. The proportion of plastic clay varies according to the proposed use of the brick or tile. Very little plastic clay is added if a high refractory product is desired, for the addition of plastic clay lessens the refractory property. However, plastic clay is added in fairly large amounts if the product is supposed to be very tough.

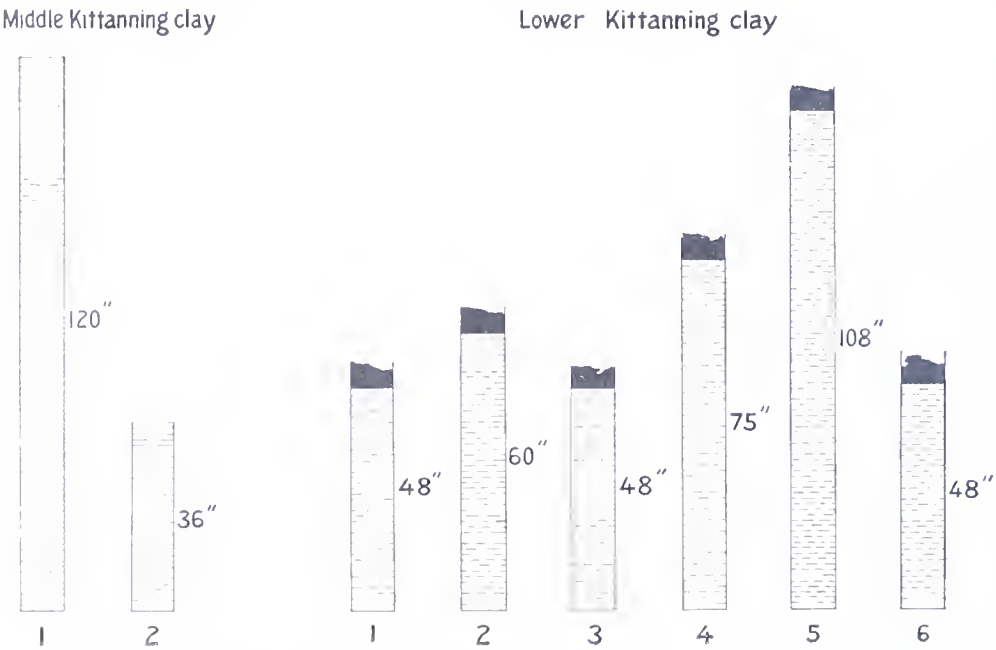


Figure 98. Sections of Middle and Lower Kittanning underclay.

1. Ba27, prospect pit. 2. Cc21, outcrop.
1. Diamond drill hole No. 1. 2. Ca18, Mauk mine. 3. Ca30, Dora mine. 4. Ba28, outcrop. 5. Aa50, McGregor No. 2 mine. 6. Ab52, outcrop.

Another variety of flint clay is the nodular or burly; it breaks with irregular surfaces that are covered with low rounded protuberances. Some of these nodules are a highly alumminous composition, in part diaspore, which gives the clay a high refractory nature. During World War II, the U. S. Bureau of Mines and the Pennsylvania Topographic and Geologic Survey made intensive investigations of the nodular flint clay in the Mercer formation as a possible source of aluminum ore.

Following is an average analysis of flint clays obtained elsewhere in Pennsylvania:

Silica	44	Magnesia	.2
Alumina	38	Alkalies	.4
Protoxide of iron	1.2	Water	14
Titanic acid	1.5		
Lime	.3		99.6

Flint clays in the Smicksburg quadrangle were noted at a few places occurring as lenses or as relatively thinner parts of plastic clays. They appear unimportant. The Bolivar flint clay, which occurs under the Upper Freeport limestone, was observed at one place in the quadrangle (Ac34), but it is poor in quality and grades into sandstone downward (fig. 96, sec. 9). Flint clay is present in the Mercer formation in the adjoining Rural Valley, Brookville, and Punxsutawney quadrangles. The Mercer formation crops out on the steep valley sides of Mahoning Creek northwest of Milton, but as was stated previously in this report, the outcrop is concealed by talus, soil, and vegetation. North of Grange in the Big Run area, a partial exposure of weathered argillaceous sandstone or very sandy clay on the road north of B.M. 1330 is taken to be the equivalent of the Mercer clay; it lies about 410 feet below the horizon of the Upper Freeport coal.

The probable presence of flint clay in the Mercer formation at some places is indicated in a few records of wells drilled for natural gas. In these records, limestone averaging about 10 feet thick is logged at an average depth of approximately 400 feet below the horizon of the Upper Freeport coal. Examination of the cuttings in some instances showed that drillers reported limestone when actually the material was flint clay. The error is understandable because flint clay is somewhat similar in appearance to fine-grained limestone and also tends to polish the bit like limestone.

Shale

Shales are abundant and well distributed in the Smicksburg quadrangle and although most of them are sandy and unsuited for fine brick, there are large supplies in some localities suitable for the manufacture of paving brick, building brick, tile, or terra cotta. The shales in the Allegheny group tend to be generally more sandy than those in the Conemaugh. The shales associated with the Lower Kittanning and Clarion coals are suitable for some of the above uses, but they usually are under considerable cover. For those interested, it is suggested that shales in the lower part of the Conemaugh in the upland in the southwestern part of the quadrangle be investigated, particularly the shale associated with the Brush Creek horizon.

SAND AND GRAVEL

Loam, sand, gravel, and mixed alluvium occur in the terraces and flood plains of the larger streams in the quadrangle. These areas are indicated on the mineral resources map by the symbol Qal. This material has not been utilized and the thickness of the deposits could not be determined. It is probable, however, that relatively thick de-

posits occur at some places and logical places to investigate would be on Mahoning Creek between Fordham and North Point, and southeast from Milton to Little Mahoning Creek.

SANDSTONE

The sandstone resources in the quadrangle are unlimited and some probably will serve for various purposes, but they practically have been untouched. Aside from rough masonry, such as building foundations and bridge abutments, little sandstone has been used for structural purposes. That which has been utilized was mostly obtained from boulders on the surface ("field stone"). Most of the sandstone used for road metal was also obtained from this source. A peculiar type of masonry or facing for dwellings used in this region consists of placing slabby sandstones with the bedding planes in a vertical position.

The sandstone beds are generally much alike, but individual sandstones vary in character from place to place, but may be locally rather uniform in bedding, texture, and color. They vary from platy through flaggy and heavy-bedded to massive. The texture varies from argillaceous through fine- and medium-grained to coarse with lenses of fine conglomerate. The colors are whitish and shades of gray and brown. Iron, usually limonite, is present locally as lenses and nodules, and upon oxidation stains the fresh surfaces of the sandstones with rusty-brown streaks.

Most of the outcropping sandstones are poorly exposed. Therefore, their character in many cases was determined by the weathered-out material or float. Sandstone is rather well distributed throughout the quadrangle and is under little cover at many places.

Figure 99. Stephenson house at McCormick.

The Saltsburg sandstone is generally well-developed and underlies much of the surface in the area surrounding Marchand. It is prominent also in the upland in the southeastern part of West Mahoning Township. The Stephenson house (fig. 99) at McCormick was reported to be constructed of sandstone obtained from the latter area. The Saltsburg is massive and about 30 feet thick in the vicinity of Georgeville.

The Mahoning sandstone, which is the basal member of the Conemaugh, is the cap rock in much of southern and western Perry and northern Porter Townhips. Usually it is thin or heavy-bedded with shale partings, but it is massive locally and may produce dimension stone at some places. Many years ago, the Mahoning sandstone was quarried in a small way a little east of Dayton, where it is in part flaggy and massive. Mahoning sandstone is shown in the foregoing graphic sections.

The Butler sandstone lies between the Upper Freeport and Lower Freeport coal beds. It commonly is thin-bedded, but is massive at some places. It is prominent along Mahoning Creek in the eastern part of the quadrangle. The Freeport and Kittanning sandstones generally are thin and irregular-bedded and contain numerous shale partings. They are conspicuous along Mahoning Creek in the vicinity of Loop, but have doubtful economic value.

Building stone probably is obtainable from the Clarion sandstone along Pine Run at the western boundary of the quadrangle where it is massive in its lower part, medium- to coarse-grained, and rather hard. It also occurs in massive beds in the vicinity of Milton (fig. 40).

The Homewood and Connoquenessing sandstones are good quarry rocks in other regions. These members crop out in the Big Run area at the north and in the steep-sided valley of Mahoning Creek northwest of Milton. Although massive, these sandstones are generally loosely cemented and friable. From the standpoint of transportation facilities, they have little economic value.

LIMESTONE

The limestones in the Smicksburg quadrangle have little commercial value. Before transportation facilities were good, some of them had considerable local importance, as was observed from the numerous pits and drifts that mark the outcrops. Now that better transportation facilities are available, most of the lime used in this area is being shipped from other places. However, some limestone still is being worked for local agricultural use. The farmers burn it in an open heap (fig. 100), which consists of alternating layers of limestone and coal. Three small commercial plants were producing pulverized limestone for local trade.

The limestones in the lower part of the Conemaugh group are thin and impure and lack economic value. In the Allegheny group, the Upper Freeport and Vanport limestones are the important beds. They

Figure 100. Open heap burning of limestone.

are relatively thicker, purer, are fairly persistent, and, therefore, constitute the available reserves. The Johnstown limestone is of fair thickness and quality locally and had been worked at a few places. Most of the limestone is dug in open pits that follow along the outcrop. Some workings follow the outcrop into the hill in drifts.

Upper Freeport Limestone

Excepting northeast Perry, northwest Young, and southeast Oliver Townships, where the Upper Freeport limestone appears to be missing, it has a wide distribution throughout the quadrangle. Not only was it observed at numerous places along the outcrop, but it also is indicated on numerous records of diamond core drill holes (see foregoing graphic sections) and wells drilled for natural gas. The outcrop of the limestone may be followed on the mineral resources map with respect to the crop line of the Upper Freeport coal which it underlies from 1 to 25 feet. Outcrops, drifts, and pits are indicated by symbols. The limestone varies considerably in thickness. It has a maximum observed thickness of a little over 15 feet and a reported thickness of 20 feet. It may occur as a single bed, but usually is in two or more benches separated by clay or shale. The limestone also varies widely in physical and chemical composition; certain layers are rather pure, whereas others are impure.

The presence of the Upper Freeport limestone is indicated by abandoned openings west and southwest of Frostburg (Ea31, 33, 43, 45, Eb1, 4, 5, 8, 10, 11, 13). In a small pit about 1.2 miles northwest of Frostburg (Ea34) the limestone is at least 108 inches thick (fig. 101, sec. 2). It also had been worked in the knoll 0.6 of a mile farther northwest (Ea25); and in another knoll to the north (Ea22), the limestone was exposed in an active quarry where it occurs in two workable benches 41 and 17 inches thick, respectively, separated by 10

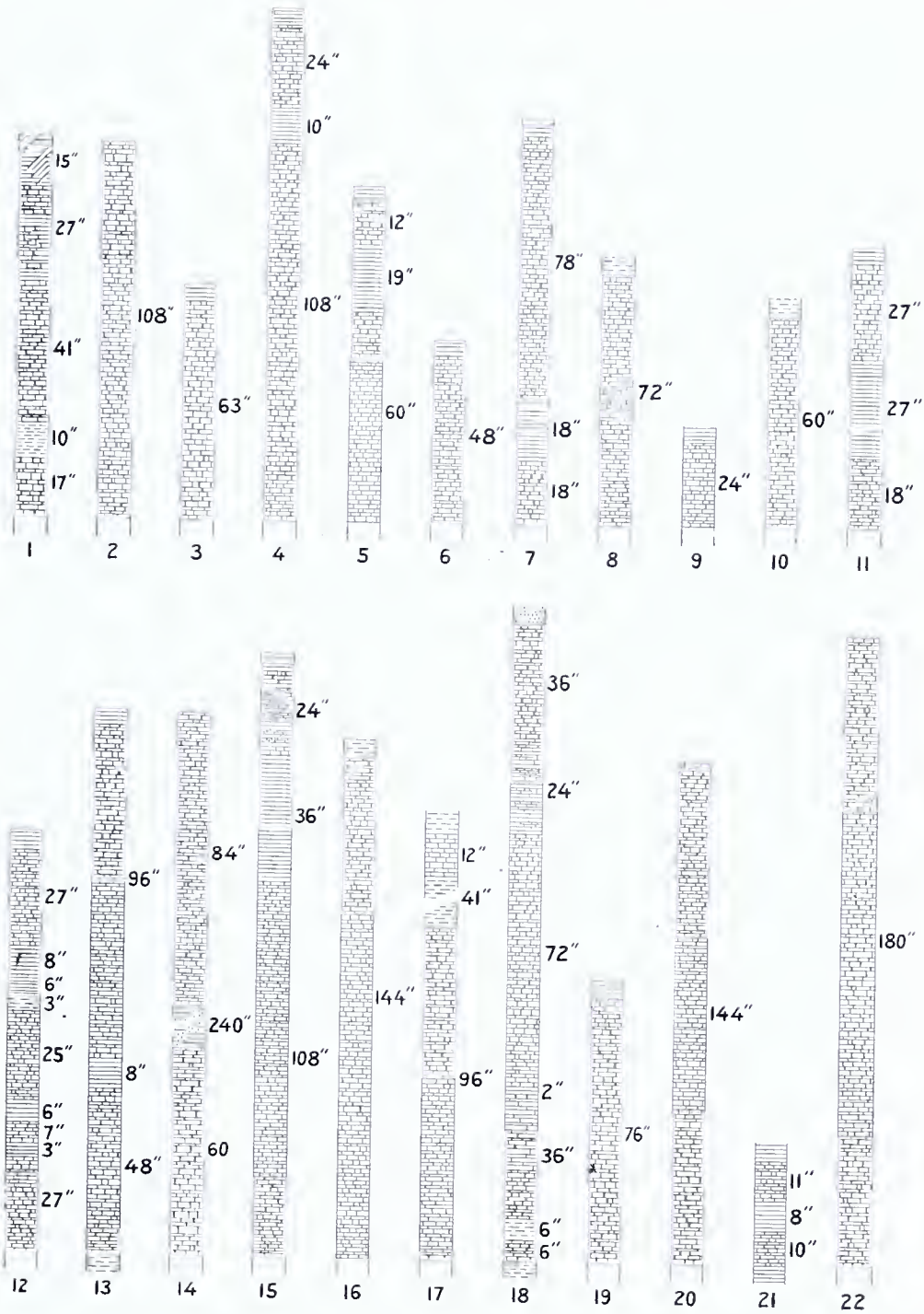


Figure 101. Sections of Upper Freeport limestone.

1. Ea22, quarry. 2. Ea34, quarry. 3. Da47, quarry. 4. Da37, mine. 5. Ca13, quarry. 6. Ba25, quarry. 7. Ab15, quarry. 8. Bb20, mine. 9. Ab34, quarry. 10. Bc3, quarry. 11. Cb19, quarry. 12. Eb23, quarry. 13. Db33, mine, Depp Bros. Lime Co. 14. Dc20, quarry. 15. Cc31, quarry. 16. Ac34, quarry. 17. Bd4, mine. 18. Cd6, mine, Smicksburg Lime Co. 19. Dd2, quarry. 20. Ed12, quarry. 21. Ed9, quarry. 22. De2, mine.

inches of clay (fig. 101, sec. 1). Platt[66] made reference to the Upper Freeport limestone in this locality and includes the following analysis:

Carbonate of lime	91.875
Carbonate of magnesia	2.421
Oxide of iron and alumina	1.312
Phosphorus	.012
Insoluble residue	3.130

Two abandoned limestone pits are a little north of Grange (Da41, 45). A small quarry about 0.8 of a mile northwest of Grange (Da47) disclosed 63 inches of limestone in a solid bed (fig. 101, sec. 3). Abandoned small quarries were noted west of Grange near the Perry Township line (Da35, 55, 57, 58). A drift was open on the Upper Freeport limestone on the north side of Route 536, about 1.1 miles northwest of Grange (Da37) where the bed totals 132 inches thick (fig. 101, sec. 4). An analysis of the limestone is given in the following table.

On Route 536 about 1.5 miles southeast of Ringgold, two limestone beds are separated by about 30 feet of shale (Ca7, 11). The lower bed is only partly exposed. As determined from a mine survey, it is 215 feet above the Lower Kittanning coal. The upper limestone has an exposed thickness of 24 inches. As was previously discussed in this report, the upper bed is regarded as an expanded Upper Freeport limestone section.

Upper Freeport limestone had been quarried in the hilltop northeast of the above location (Ca4). It is exposed in a small quarry above Caylor Run (Ca13) where it has a total thickness of 72 inches (fig. 101, sec. 5). An opening had at one time been made on the Reed farm a little east of Ringgold (Ca2) where the limestone reportedly is 12 feet thick. An opening also had been made above Caylor Run, south of Ringgold. A caved drift is near the head of the east fork of Eagle Run (Ba17). A small quarry in the hill northwest of Timblin (Ba25) disclosed 4 feet of good limestone (fig. 101, sec. 6) and the Upper Freeport coal and limestone had been worked in a drift (Ba24) on the east side of the hill above Eagle Run.

Upper Freeport limestone had been quarried a little east of Mt. Tabor (Aa23). It is partly exposed at outcrop (Aa2) on a lane north of Mt. Tabor. The lime had been worked at two places where it underlies the hilltop south of New Salem (Aa33, 39). A poor outcrop of the limestone was noted on the lane that crosses the hill east of Sugareamp Run (Aa45). An active quarry on the Yarger farm north of McGregor (Aa15) revealed good limestone occurring in two benches totaling 96 inches thick (fig. 101, sec. 7). An analysis of the bed is shown in the following table.

Platt[67] reports that the Upper Freeport limestone had been worked many years ago in the vicinity of Porter and was used for flux in the old Phoenix furnace. A drift (Bb20) on the limestone on the south side of Nye Branch northwest of Porter revealed 6 feet of limestone (fig. 101, sec. 8). Limestone was dug in a small pit north of Porter. An abandoned quarry is situated at the head of Foundry

[66] Platt, W. G., H6, p. 17.
[67] Platt, W. G., H6, p. 5.

Run (Bb31). The bed is 60 inches thick (fig. 101, sec. 10) where it is being worked in a knoll to the south (Bc3). It also had been opened in the knoll a little to the southwest (Bc4). The limestone had been taken out in a drift (Bb49) on Sugarcamp Run, south of Porter. In a quarry (Cb19) on Hamilton Run, southeast of Porter, the limestone is exposed in two benches 27 and 18 inches thick and separated by 27 inches of shale (fig. 101, sec. 11).

The Upper Freeport limestone had been dug at a few places along Foundry Run (Db2, 12, 14, 15, 16, 27), which enters Mahoning Creek at Hamilton. Platt[68] reported the limestone to have been opened on the Iler farm, which is located on the hill northwest of Hamilton, and gives the following description:

> It is 10 feet thick, divided into three layers by small partings of shale. The top layer is an impure cement: the centre bench consists of excellent limestone; the bottom bench though less pure than that above makes good quarry lime. Minute fossil shells were observed in all three benches. The following analysis by Mr. McCreath will show the character of stone in the upper and middle benches:

Analysis of Upper Freeport limestone

	Top bench	*Middle bench*
Carbonate of lime	48.571	90.000
Carbonate of magnesia	23.762	2.860
Oxide of iron and alumina	7.250	1.285
Phosphorus	.032	.011
Insoluble residue	16.660	3.480

Abandoned openings on the Upper Freeport limestone are along Perryville Run, north of Hamilton (Db5, 8, Eb15, 16). The limestone was being quarried on the Cook farm and pulverized in a small plant (Eb23). The bed contains numerous clay and shale partings and the total thickness of limestone is 86 inches (fig. 101, sec. 12).

The Upper Freeport limestone is just above the level of Mahoning Creek east of Fordham (Fe3). An abandoned quarry (Fe2) is at the east end of the village. The limestone crops out on the road northward from Fordham (Fb29) and it had been worked in a small quarry where it crops out on the hillside farther north (Eb51). A small opening (Ec1) was made on the point of the hill south of Hamilton and the stone crops out on the road a little farther south (Ec4).

A limestone mine and pulverizing plant (Db33), operated by the Depp brothers, is on the hillside southwest of Hamilton. The bed here occurs in two benches separated by 8 inches of dark clay shale. The upper bench is 96 inches thick and the lower bench is 48 inches (fig. 101, sec. 13). An analysis of the limestone is shown on the following table. A drift (Dc3) had been opened on the limestone on the hillside southwest of the Depp mine, and another abandoned drift (Db30) is up the small run to the west.

The outcrop of the Upper Freeport limestone was located by abandoned openings on the south side of Mahoning Creek (Dc15, 16). It occurs in two major benches on the run below Gamble School

[68] Platt, W. G., H6, p. 10.

(Dc20) separated by 20 feet of shale and thin sandstone. The upper bench is 84 inches thick and the lower bench 60 inches (fig. 101, sec. 14).

Some small limestone pits are along Steer Run, north of North Point (Cb16, Cc4, 3). The limestone had been quarried and sold to local trade on Carr Run, south of North Point (Cc31). It has a total workable thickness of 108 inches (fig. 101, sec. 15). An abandoned limestone quarry is on the north side of the creek near the point of the hill (Cc18). A drift was opened on the limestone on the steep hillside on the south side of the creek (Cc29) and limestone had been worked in the little cove formed by the bend of Mahoning Creek, south of Loop (Cc23, Bc36).

A weathered outcrop (Ac28) of the Upper Freeport limestone shows on the Milton-Dayton road. It is quarried for local use in the bluff above Little Mahoning Creek east of Dayton (Ac34) and is there a good limestone 12 feet thick (fig. 101, sec. 16). The limestone also had been quarried a little to the north in the same hill (Ac29). Another quarry (Bc31) is on the north bank of Little Mahoning Creek south of Smicksburg Station. The outcrop shows on the improved road a little to the east (Bc32).

The Upper Freeport limestone had been mined in the steep bank on Little Mahoning Creek at Smicksburg (Bd4). Fallen timbers blocked the entrance, but it was learned indirectly that the bed is 10 feet thick and yields good quality stone.

About 0.7 of a mile southeast of Smicksburg (Cd6), the Smicksburg Lime Co. (fig. 102) mine and pulverize Upper Freeport for

Figure 102. Mine and pulverizing plant of the Smicksburg Lime Co.

agricultural use. It was said that the limestone was worked here for more than 60 years. The bed has a maximum thickness of about 12 feet, the average being 6 feet. It contains irregular shale partings. A typical section of the limestone is shown on figure 101, section 18. The stone is pulverized to pass through a 16-mesh screen. An analysis of the limestone is shown on the following table.

The Upper Freeport limestone, although variable in thickness, appears to be persistent along Little Mahoning Creek to the eastern boundary of the quadrangle. The bed had been opened at many places, but these workings were usually concealed. Therefore, information about the bed was obtained indirectly.

A thickness of 6 feet was reported where it had been quarried north of McCormick (Dd13). It is said to be 15 feet thick in a drift (De2) south of McCormick. The top of the bed is exposed in a cut on the Baltimore & Ohio Railroad west of Trade City Station (Dd2). It is reported to have a thickness of 12 feet where it was worked in a quarry east of Trade City Station (Ed5). Two layers of the limestone are exposed in a small quarry north of Mottarns Mill (Ed9). They are 11 and 10 inches thick (fig. 101, sec. 21). It could not be determined if this exposure is representative of the total thickness of the limestone or if it is only the top part of a thicker bed.

Partial exposures of the Upper Freeport limestone were seen in the area about Marion Center (Fe26, 30, 32, 36, Ff3, 14, 36) and thicknesses from 3 to 4 feet were reported.

Vanport limestone

The Vanport limestone, locally called the "blue lime," crops out in the northwestern part of the Smicksburg quadrangle. The crop line is shown on the mineral resources map. The bed is developed along Pine Run and Big Run and in their tributaries. It normally is 3 to 5 feet thick, occurs as a solid compact bed, and is purer than the Upper Freeport. Many openings had been made on the Vanport by the farmers who use it for agricultural purposes, but most of these openings have been abandoned and the limestone is concealed by the slumping of overlying shale.

The Vanport was being mined in a drift (Aa31) along Mudlick Run, south of New Salem where it has a thickness of 54 inches (fig. 103, sec. 1). Some limestone said to be 3 feet thick had been removed in a quarry on a small stream to the southeast (Aa43) (fig. 103, sec. 2). A diamond drill hole (No. 1) put down a little east of Ringgold found a solid bed of limestone 5 feet thick (fig. 103, sec. 3).

The top of the Vanport shows in the railroad cut west of Dora (Ca27) and the bed has been worked in a small way at two places near-by (Ca29, Ba50). The limestone is reported to be 4 feet thick (fig. 103, sec. 4) below where the Lower Kittanning coal had been mined along a small stream northeast of Dora (Ca21). Some of the stone had been quarried on Middle Branch (Cb4), southeast of Dora where it is 46 inches thick (fig. 103, sec. 8). A drift (Da49) had been opened on the limestone on a tributary of Pine Run, east of Dora and diselosed the Vanport to be 51 inches thick (fig. 103, sec. 7). An analysis of the limestone made of samples from the stockpile is shown

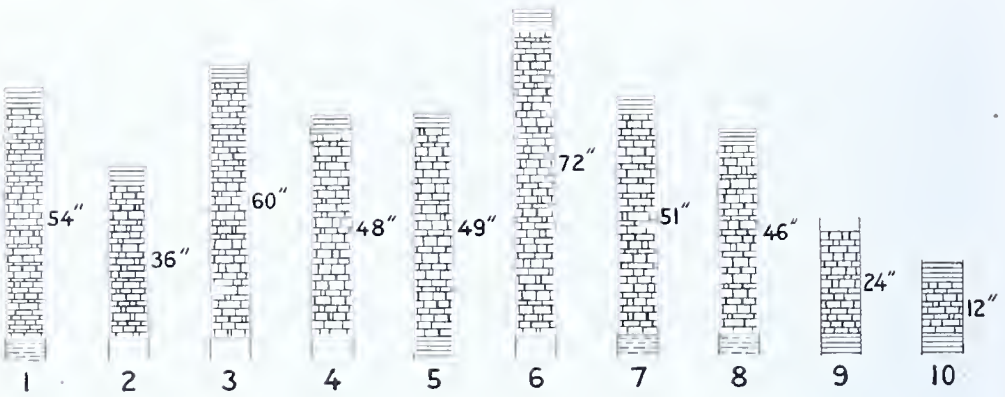


Figure 103. Sections of Vanport limestone.

1. Aa31, mine. 2. Aa43, quarry. 3. Diamond drill hole No. 1. 4. Ca21, quarry. 5. Da20, mine. 6. Da19, quarry. 7. Da49, mine. 8. Cb4, quarry. 9. Diamond drill hole No. 4. 10. Diamond drill hole No. 70.

in the following table. The presence of the Vanport on the headwater of Pine Run is indicated by abandoned quarries (Ca37, 38, 39).

The Vanport occurs in the upland on and near the axis of the Sprankle Mills anticline in the Big Run area. Limestone had been removed at various places, but none of the operations were active when the area was surveyed. The bed appears to be very persistent at outcrop and reportedly is 3 to 6 feet thick. A small quarry (Da19) on the knob southwest of Big Run revealed 6 feet of good limestone (fig. 103, sec. 6), whereas in a drift about 1,000 feet to the east (Da20), the thickness is reduced to 49 inches (fig. 103, sec. 5). An analysis of the limestone from the former place is shown in the following table.

As was discussed previously in this report, the Vanport limestone is generally lacking where its horizon crops out in the area about Milton, but it is reported to occur along the small valley of the stream that heads north of McGregor.

Analysis of limestones in the Smicksburg quadrangle

	1	2	3	4	5	6
$CaCO_3$	82.900	66.500	82.250	94.600	92.000	89.500
$MgCO_3$	6.620	12.400	5.620	1.990	1.415	1.760
Al_2O_3, Fe_2O_3	3.300	6.280	3.550	1.870	1.930	2.370
SiO_2	5.810	12.650	7.140	.890	3.830	5.390
P	.058	.073	.034	.079	.064	.043

Name and location of foregoing specimens

1. Upper Freeport limestone, mine, northwest of Grange (Da37).
2. Upper Freeport limestone, Depp Bros. mine, southwest of Hamilton (Db33).
3. Upper Freeport limestone, Smicksburg Lime Co. mine, southeast of Smicksburg (Cd6).
4. Vanport limestone, quarry, northwest of Grange (Da19).
5. Vanport limestone, mine, northwest of Grange (Da49).
6. Upper Freeport limestone, quarry, northwest of McGregor (Ab15).

IRON ORE

The iron ores in the Smicksburg quadrangle, insofar as could be observed, are not regarded as having economic value. The buhrstone iron ore which occurs immediately on top of the Vanport limestone and commonly is present where the limestone is absent, consists of concentrations of impure siderite, limonite, and hematite. The ore is usually but a few inches thick and is in the form of lenses and concretions, which contain approximately 34 percent iron. The buhrstone iron ore was noted particularly about Milton, where it served to mark the horizon of the limestone, which is lacking in that area. About 1860, the Phoenix furnace, the site of which is on the north side of Mahoning Creek about one mile northwest of Milton, used hematite from 2 to 4 feet thick that was mined near Milton. The enterprise was short-lived because it was difficult to transport the metal to market. The ore itself proved lean and impure.

WATER RESOURCES

The Smicksburg quadrangle has an abundant supply of water. Surface water is everywhere available from the numerous runs and creeks. Springs, shallow dug wells, and deeper drilled wells furnish water for domestic purposes. Precipitation is adequate for agriculture.

Precipitation

The United States Weather Bureau station nearest to the Smicksburg quadrangle having more complete records is at Brookville. Therefore, the data compiled from those records for the Brookville atlas are more nearly representative for this area and are used in this report.

The mean annual precipitation as determined from records for Brookville is 40.22 inches. Records are presented in the foregoing chapter on climate from the years 1916 to 1940, inclusive. Incomplete records for a few months during that period prevented the computing of an annual mean for nine of the years. The maximum yearly amount recorded at the station was 51.01 inches in 1937 and the minimum was 30.26 inches in 1930.

The precipitation records for Pennsylvania are published in detail by the United States Weather Bureau in their monthly and annual Climatological Data.

Run-off

About one-quarter of the water that falls as rain runs off the surface; a small part evaporates and passes back into the atmosphere, either directly by evaporation from the surface or indirectly in the process of respiration by plants. The rest soaks into the ground, but ultimately appears as springs and seeps.

Records from the stream-flow gaging station on Mahoning Creek near Dayton over a period of 17 years (1920-1937) show an average discharge of 565 second-feet. The maximum discharge observed is 22,800 second-feet on March 18, 1936 (gage height, 14.53 feet). The minimum is 8.0 second-feet on October 17, 1928 (gage height, 1.40 feet). The drainage area is 321 square miles.

Records from the stream-flow gaging station on Little Mahoning Creek at McCormick from October 1939 to September 1942 indicate a maximum discharge of 3,480 second-feet on March 31, 1940 (maximum gage height 11.94 feet, March 4, 1941), and a minimum discharge of 0.9 second-foot on August 9, 1941. The drainage area is 87.4 square miles.

The gaging-station records are published by the United States Geological Survey and The Pennsylvania Department of Forests and Waters.

The maximum run-off is generally during March and April. December, January and February have greater than average run-off records unless the streams are frozen. The summer and fall months are variable and for different years show above average or lower than average run-off records.

Ground Water

Ground water is that which sinks into the earth and percolates downward through crevices and pores in the rocks until it reaches either an impervious stratum or else the level of saturation, called the water table. If an impervious stratum, such as clay under a coal bed, is encountered, the water is blocked in its downward passage and follows down the dip of the bed, eventually emerging at the outcrop as springs or seeps. If, on the other hand, it first reaches the water table, it tends temporarily to raise the level of that table, causing increased out-flow in the valleys where the table intersects the surface. The underground waters have the same direction of movement as the surface waters. In a similar way the water table follows the topography of the surface, but its slope is more gentle. As a general rule, the water table is near the surface in the valleys, where it coincides with the surface of streams, lakes, and ponds, and is farther from the surface on the uplands, where its distance from the surface is indicated by the water level in wells. Its height may vary considerably, depending upon the rain fall. During a prolonged dry season, the water level may drop beneath the shallower wells and they become dry. The position varies with the character of the surface and of the underlying rock. The water table will be nearer the surface in broad, flat areas than near sharp declivities where the water may drain away readily. It will be nearer the surface underlain by fine-grained impervious rocks, such as shales, than that underlain by coarse-grained, porous sandstone.

The Smicksburg quadrangle is well supplied with water. Springs are numerous. They are particularly abundant at the horizon of some of the coal beds. In fact, the position of some of the coal beds was mapped on the basis of springs and seeps. Water issuing from under a coal bed may be sulphurous, particularly where the coal has been mined. Springs supply much of the water used on the farms; in many cases they are high enough above the buildings that a gravity system is adaptable. Dug wells also supply water in rural areas. The yield of many of the springs and dug wells varies with the wet and dry seasons and, therefore, they are not reliable. Deeper drilled

wells have, to a large extent, replaced springs and dug wells, especially in the settlements.

Sandstones are the largest producers of water. The sandstones in the Conemaugh, Allegheny, Pottsville, and Pocono are good water bearers locally, but at some places their yield is small because within a relatively short distance a given sandstone may grade into shale. However, sandstone may be expected to occur locally in at least one of the formations and it may only be a problem of how deep a well must be drilled to encounter water. Theoretically, ground water may penetrate as far into the surface of the earth as it is possible for cracks and pores to remain open. This distance is estimated to be about 11 miles. However, drilling in this area shows that water is not often encountered beyond 500 feet and the average is considerably less. Salt water occurs at about 1,000 feet and more, but this is connate water, or water that was deposited simultaneously with the deposition of solid sediments and has not since its deposition existed as surface water or atmospheric moisture.

The depth to water is logged on many of the records of wells drilled for natural gas in the quadrangle. These data are indicated on plates 7, 8, 9, and 10 accompanying this report. Although the yield of water is not given, the information has some value in forecasting the probable depth that water may be expected. At some places, water is obtained from abandoned gas wells or wells that failed to produce gas, but encountered water.

Artesian Conditions

Because of the structure of the rocks in the Smieksburg quadrangle, wells under artesian pressure may be encountered. It is not known if any of the wells in this area are under sufficient artesian pressure to cause them to flow at the surface, but drillers report that in wells at some places the water rises more than 25 feet above the level at which it was encountered. The most likely places in the quadrangle that wells may be found under artesian pressure are on or near the axes of the synclines where sandstones overlain and underlain by relatively impervious shales received water at their outcrops and may thus constitute reservoirs.

Public Water Supplies

Dayton borough is supplied with water from two drilled wells in the Freeport sandstone, 130 and 128 feet deep, yielding a total of about 144 gallons a minute. The wells are 8 inches in diameter and are cased to a depth of 30 feet. The depth to water level is 15 feet.

Sagamore is supplied by four wells drilled by the Buffalo & Susquehanna Coal & Coke Company. Water is lifted from the upper part of the Allegheny group by deep well pumps to a storage reservoir having a capacity of 35,000 gallons. The distribution is by gravity. The average daily consumption is 30,000 gallons.

Marion Center gets its water supply from a spring at the horizon of the Upper Freeport coal.

Analyses of waters in and near the Smicksburg Quadrangle (Parts per million)

No.	Depth of well (feet)	Total dissolved solids	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) Potassium (K)	Bicarbonate radicle (HCO_3)	Sulphate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Total hardness as $CaCO_3$ (calculated)	Temperature (°F)
505	130	b399	—	8.89	654	—	bd30	94	227	c1.5	0	e250	—
506	128	292	8.4	3.30	71	13	1.7 3.8	108	129	1.5	.08	231	50
1,016	—	197	9.2	.06	36	11	.9 1.8	27	113	1.4	4.0	135	49
502	170	3,186	16	10.54	188	37	939 18	167	72	1,761	.65	622	—
503	140	b384	—	42	632	—	bd33	21	225	32	.20	e225	—

* Leggette, R. M., Ground Water in northwestern Pennsylvania: Pennsylvania Topog. and Geol. Survey, Bull. W3, 1936.

Nos. 505 and 506 represent water samples from Freeport sandstone from wells one-fourth of a mile northwest of Dayton. No. 1016 is from a spring near Marion Center. Nos. 502 and 503 are from wells in upper part of Allegheny group in Punxsutawney.

Water Power and Flood Control

Water power is not being used within the quadrangle at the present time. Because of the low gradient and fluctuating volume of the streams and the availability of cheap coal, it is quite unlikely that water power projects will be considered.

The valleys of Mahoning and Little Mahoning creeks now are the reservoir of a flood control dam situated on Mahoning Creek, one and one-fourth miles west of the Smicksburg quadrangle. The reservoir when full will reach a level of 1,162 feet and the slack water will extend to near Hamilton on Mahoning Creek and to near McCormick on Little Mahoning Creek. Data on Mahoning dam was given in the chapter on drainage.

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DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PENNSYLVANIA DEPARTMENT OF INTERNAL AFFAIRS
WILLIAM S. LIVENGOOD, JR., SECRETARY
TOPOGRAPHIC AND GEOLOGIC SURVEY
GEORGE H. ASHLEY, STATE GEOLOGIST

TOPOGRAPHIC AND GEOLOGIC
ATLAS OF PENNSYLVANIA
SHEET 55, SMICKSBURG AREA, PLATE II

79°15′ 10′ (Brookville) 5′ 79°00′ 41°00′

EXPLANATION

SEDIMENTARY ROCKS

Qal — Alluvium
(in flood plains and valley bottoms)

Ccm — Conemaugh group
(Light to dark shale, shaly to massive sandstone red beds, thin limestone and thin coal beds. Lower part only of group preserved.)

Ca — Allegheny group
Light to dark shale, shaly to massive sandstone. limestone, valuable coal beds and plastic clay. Upper Freeport coal at top, Brookville coal at base.)

Cpv — Pottsville series
(Massive Homewood and Connoquenessing sandstone with Mercer member.)

Cbg — Pocono series
(Burgoon sandstone)

MAP OF THE SMICKSBURG QUADRANGLE, PENNSYLVANIA

Showing Areal Geology

Base from U. S. Geological Survey topographic map of Smicksburg quadrangle, Pennsylvania. Surveyed in 1906 and 1907-1938.

Geology by Marchant N. Shaffner

Scale 1/62500

1 0 1 2 3 4 Miles

1 1/2 0 1 2 3 4 5 Kilometers

Contour interval 20 feet

Datum is mean sea level

1945

ENGRAVED OCT. 1908 BY U.S.G.S.

ENGRAVED BY F. H. M. KLINGE LITHO ZABEL BROS. INC. PHILA. PA

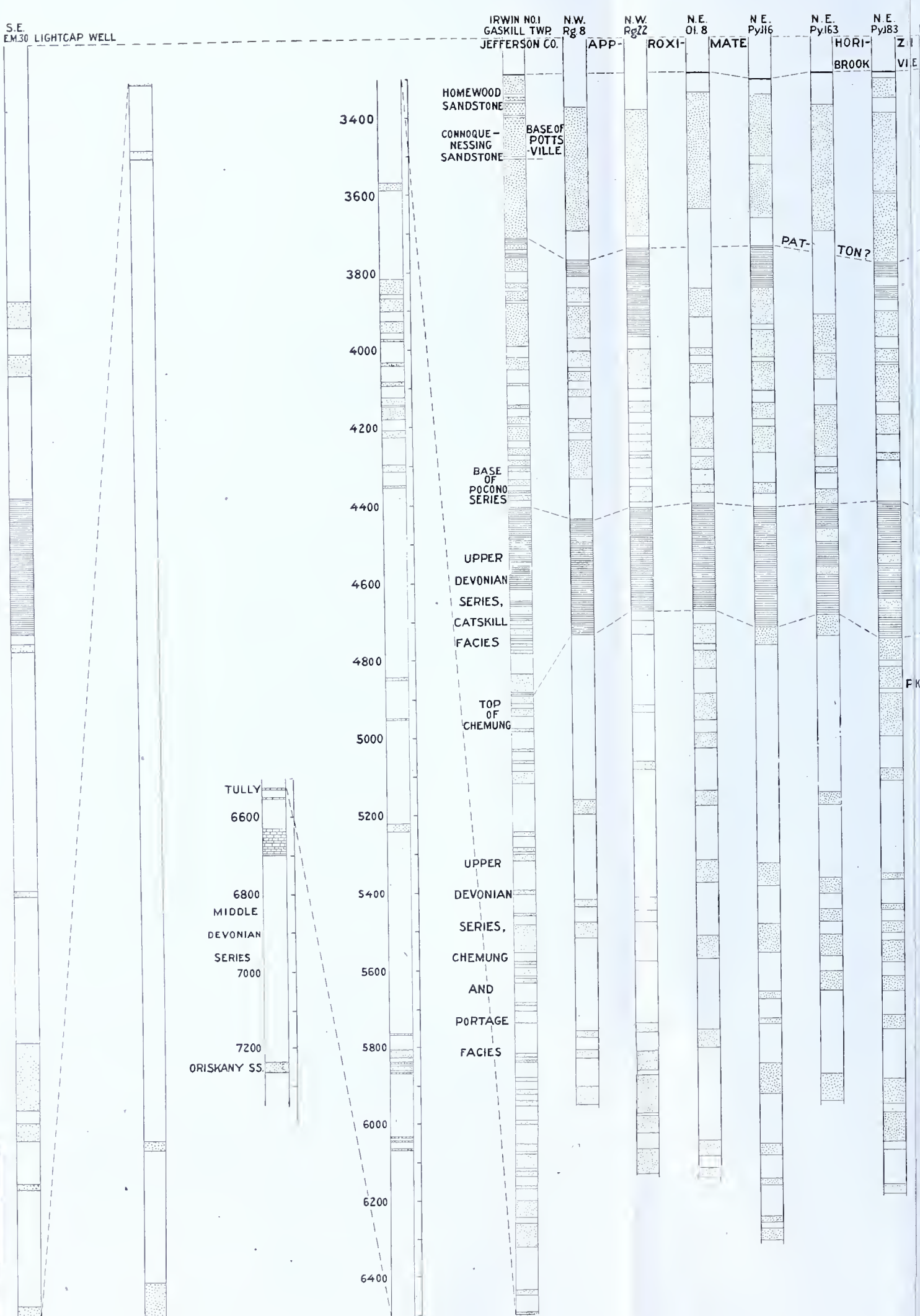
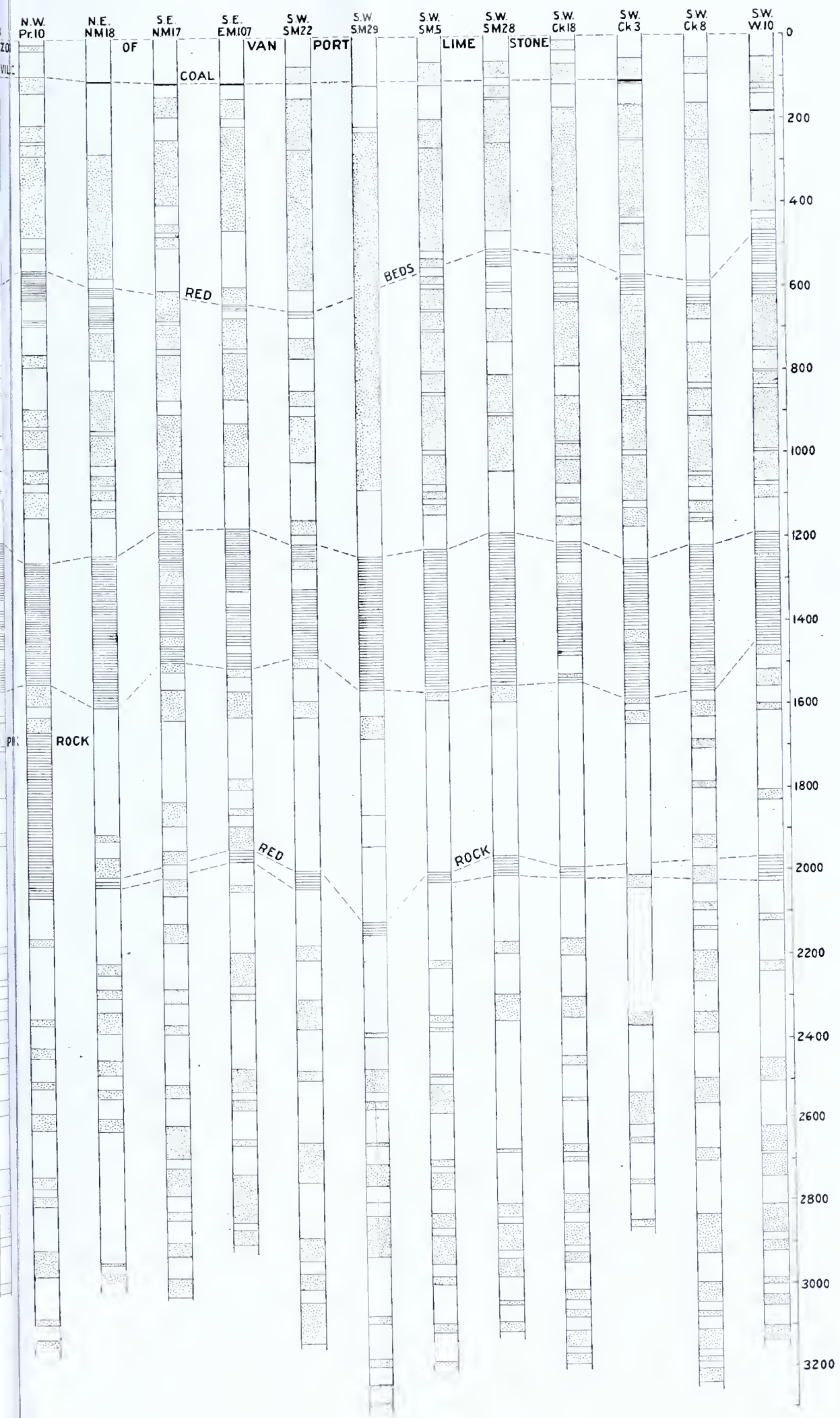


PLATE 5. SECTIONS FROM GAS WELL RECORDS SHOWIN



WING THE NATURE OF THE SUBSURFACE STRATA.

U. S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

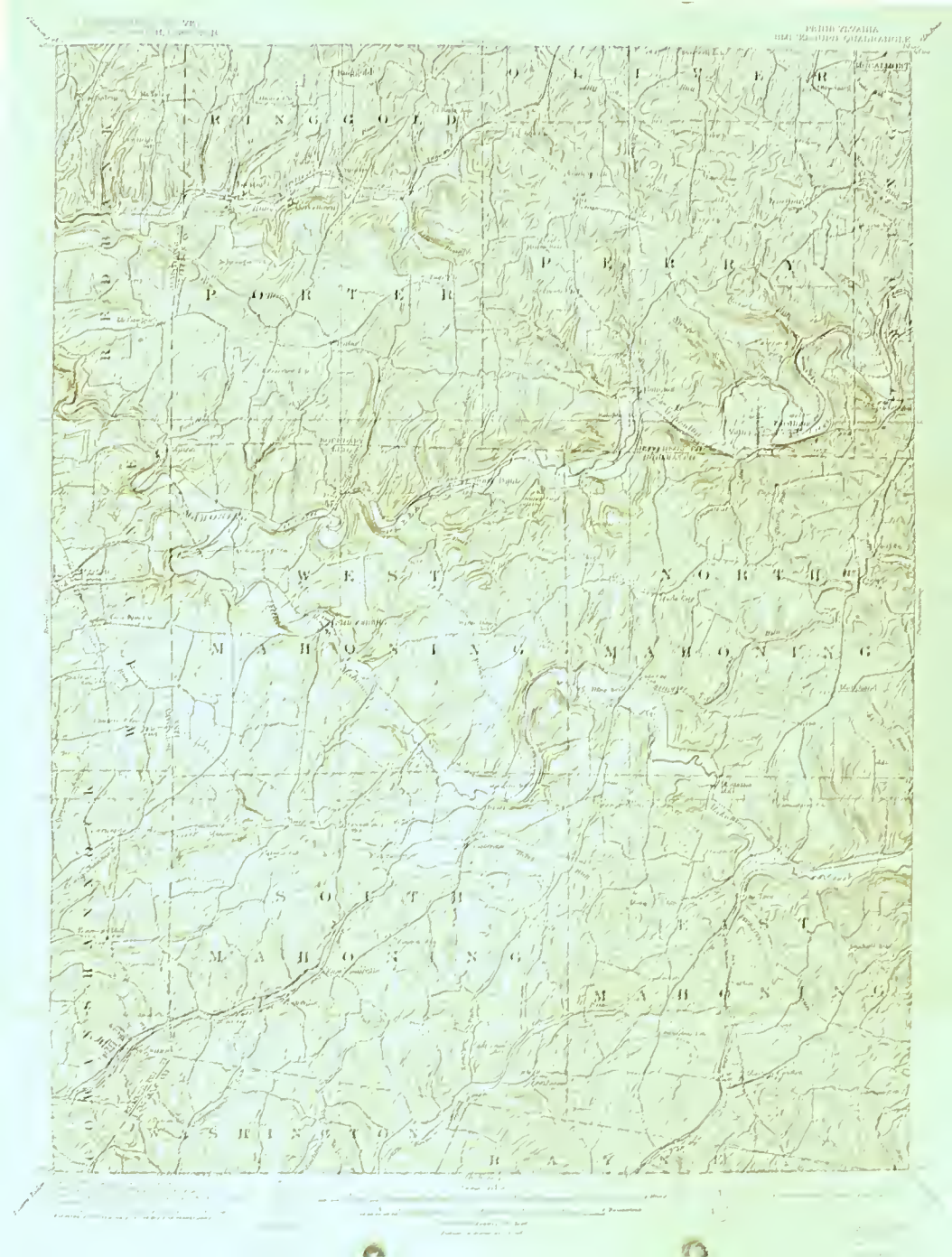
PENNSYLVANIA DEPARTMENT OF INTERNAL AFFAIRS

TOPOGRAPHIC AND GEOLOGIC SURVEY

ATLAS OF PENNSYLVANIA

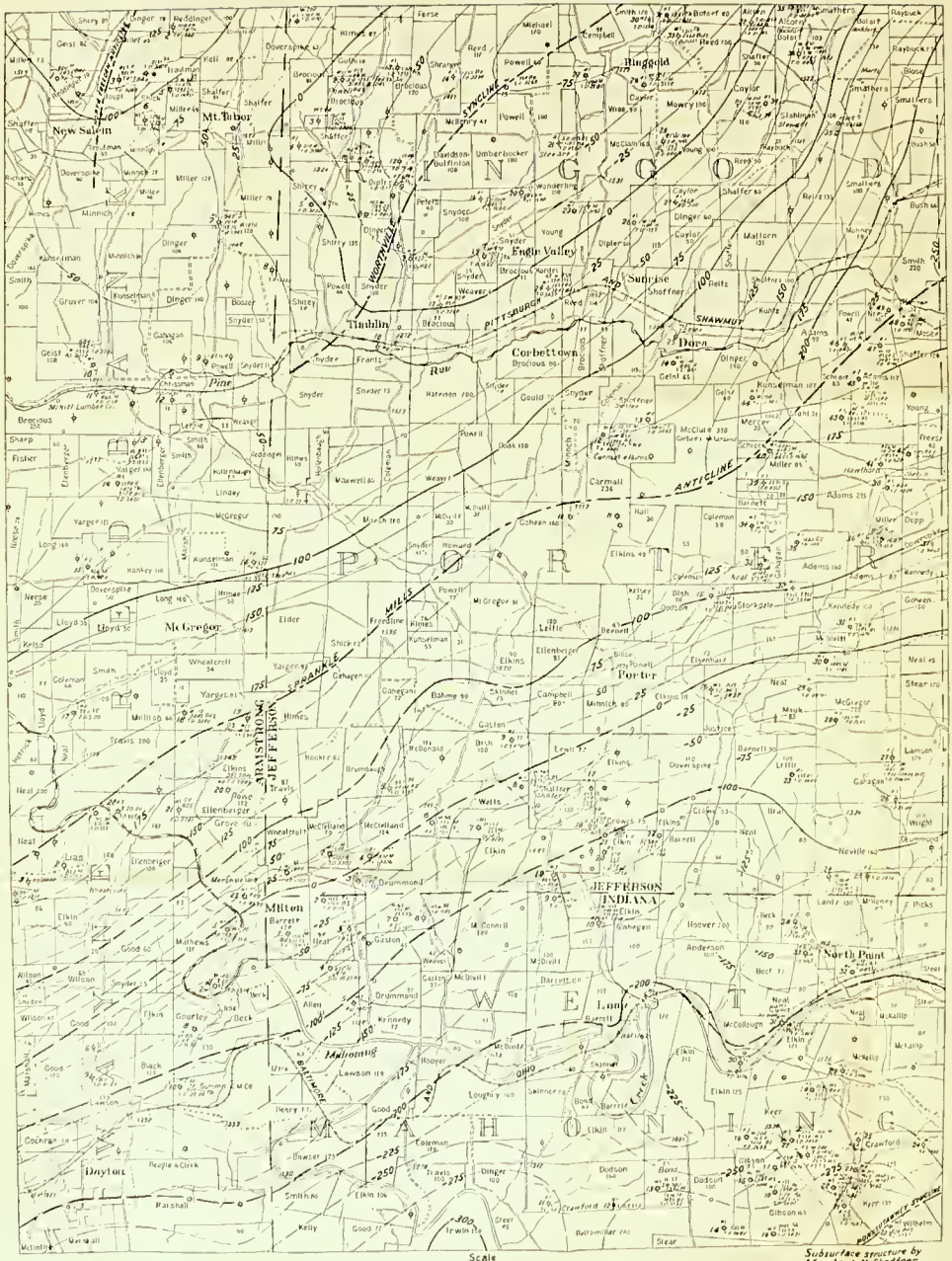
MAP OF THE SMICKSBURG QUADRANGLE, PENNSYLVANIA

Showing Mineral Resources


RINGGOLD
POTTER
POTTER
WEST
NORTH
MAHONING
MAHONING
MAHONING
MAHONING
SOUTH
WASHINGTON

SMICKSBURG QUADRANGLE, NORTHWEST QUARTER

PLATE 7



EXPLANATION

- Productive gas well
- Abandoned gas well
- Show of gas, well abandoned
- Dry well
- Well, history unknown

15 — Map number of well
*2 — Farm number of well
W 130 — Depth from surface to fresh water
S W 900 — Depth from surface to salt water
S.O. — Depth from surface to show of oil
1100 / 2750 — Depth from surface to pay in sand
3105 / T.D. 3201 — Total depth of well

Names in vertical letters are on original property line map. Names in italic are corrections. Acreage is in vertical numbers.

Subsurface structure contours based on top of Catskill red beds. Contour interval 25 feet. Datum, mean sea level.

1302 — Road intersection. Elevation from Topographic maps.

SANDS

BI	Big Injun
Sq	Squaw
G1	First Gas
G2	Second Gas
Ba	Berea
M	Murrysville
H	Hundred-foot
Th	Thirty-foot
Br	Boulder
Sn	Snee
B3	Bayard Stray
B	Bayard
G	Gordon
G3	Gordon Stray
E	Elizabeth
E3	Elizabeth Stray
W1	First Warren
W2	Second Warren
W3	Third Warren
W4	Fourth Warren
W5	Fifth Warren
333	Speechley Stray Stray
33	Speechley Stray
3	Speechley
T	Tiona
B1	First Balltown
B2	Second Balltown
Sh	Sheffield
Bd1	First Bradford
Bd2	Second Bradford
Bd3	Third Bradford
K1	First Kane
K2	Second Kane
K3	Third Kane
E1	First Elk
E2	Second Elk
E3	Third Elk

Scale

0 2000 4000 6000 8000 10000 Feet

0 1 2 Miles

Subsurface structure by Marchant M. Shaffner

SMICKSBURG QUADRANGLE, NORTHEAST QUARTER

PLATE 8

EXPLANATION

- Productive gas well
- Abandoned gas well
- Show of gas will abandoned
- Dry well
- Well, history unknown

15 Map number of well

*/ Farm number of well

W 150 Depth from surface to fresh water

S W 900 Depth from surface to salt water

S 0 Depth from surface to show of oil

1100

2750 - Depth from surface to pay in sand

3105 ,

T D 2611 Total depth of well

Names in vertical letters are on original property lines. Map names in italic are corrections. Acreage is in vertical numbers.

Subsurface structure (contours based on top of Catskill red beds. Contour interval 25 feet. Datum, mean sea level.

1332 Road intersection. Elevation from Topographic maps.

SANDS

Bi	Big Injun
Sq	Squaw
G1	First Gas
G2	Second Gas
Be	Berea
M	Murrysville
H	Hundred-foot
Th	Thirty-foot
Br	Boulder
Sn	Snee
B1	Bayard Stray
B	Bayard
G	Gordon
G1	Gordon Stray
E	Elizabeth
E1	Elizabeth Stray
W	First Warren
W2	Second Warren
W3	Third Warren
W4	Fourth Warren
W5	Fifth Warren
333	Speechley Stray Stray
33	Speechley Stray
3	Speechley
T	Tiona
B1	First Baltimore
B2	Second Baltimore
Sh	Sheffield
Bd1	First Bradford
Bd2	Second Bradford
Bd3	Third Bradford
K	First Kane
K2	Second Kane
K3	Third Kane
E1	First Elk
E2	Second Elk
E3	Third Elk

Subsurface structure by Marchant N Shaffner

SMICKSBURG QUADRANGLE, SOUTHEAST QUARTER

PLATE 9

EXPLANATION

- Productive gas well
- Abandoned gas well
- Show of gas, well abandoned
- Dry well
- Well, history unknown

15 Map number of well
Farm number of well
W 150 Depth from surface to fresh water
S W 900 Depth from surface to salt water
S.O Depth from surface to show of oil
1102 / 2750 / 3105 Depth from surface to pay in sand
T.D 3201 Total depth of well

Names in vertical letters are on original property line map. Names in italic are corrections. Acreage is in vertical numbers.

-50 -25 0 25

Subsurface structure contours based on top of Campbell sed brds. Contour interval 25 feet. Datum, mean sea level.

X 1302 Road intersection. Elevation from Topographic map

SANDS

BI	Big Injun
Sq	Squaw
G1	First Gas
G2	Second Gas
Be	Brine
M	Murrysville
H	Hundred-foot
Th	Thirty-foot
Br	Boulder
Sn	Snee
Bs	Bayard Stray
B	Bayard
G	Gordon
GS	Gordon Stray
E	Elizabeth
ES	Elizabeth Stray
W1	First Warren
W2	Second Warren
W3	Third Warren
W4	Fourth Warren
W5	Fifth Warren
SSS	Speechley Stray Stray
SS	Speechley Stray
S	Speechley
T	Tione
B1	First Balltown
B2	Second Balltown
Sh	Shaffield
Bd1	First Bradford
Bd2	Second Bradford
Bd3	Third Bradford
K1	First Kane
K2	Second Kane
K3	Third Kane
E1	First Elk
E2	Second Elk
E3	Third Elk

Subsurface structure by Merchant & Shaffner

SMICKSBURG QUADRANGLE, SOUTHWEST QUARTER

PLATE 10

Subsurface structure by Merchant N. Shaffner

EXPLANATION

- Productive gas well
- Abandoned gas well
- Show of gas, well abandoned
- Dry well
- Well, history unknown

15	Map number of well
2	Farm number of well
W.150	Depth from surface to fresh water
S.W.900	Depth from surface to salt water
S.O.	Depth from surface to show of oil
1100 / 2750 / 3105	Depth from surface to pay in sand
T.D.3201	Total depth of well

Names in vertical letters are on original property line map. Names in italic are corrections. Acreage is in vertical numbers.

Subsurface structure contours based on top of Catskill red beds. Contour interval 25 feet. Datum, mean sea level.

1302 Road intersection. Elevation from Topographic maps.

SANDS

BI	Big Injun
Sq	Squaw
G1	First Gas
G2	Second Gas
Be	Berea
M	Murrysville
H	Hundred-foot
Th	Thirty-foot
Br	Boulder
Sn	Snee
Bs	Bayard Stray
B	Bayard
G	Gordon
GS	Gordon Stray
E	Elizabeth
ES	Elizabeth Stray
W1	First Warren
W2	Second Warren
W3	Third Warren
W4	Fourth Warren
W5	Fifth Warren
SSS	Speechley Stray Stray
SS	Speechley Stray
S	Speechley
T	Tiona
B1	First Balltown
B2	Second Balltown
Sh	Sheffield
Bd1	First Bradford
Bd2	Second Bradford
Bd3	Third Bradford
K1	First Kane
K2	Second Kane
K3	Third Kane
E1	First Elk
E2	Second Elk
E3	Third Elk